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An Illustrated Weekly Journal.

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VOL. CX.—No. 2865.] *LONDON: FRIDAY, NOVEMBER 26, 1920.* [*Registered at the General Post Office as a Newspaper.*] [PRICE...1s. 2d. BY FOREIGN POST 1s. 5d.

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See Advt. Page 134, Nov. 19.
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Notice is Hereby Given, that

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UNIVERSITY ENGINEERING COLLEGE, Westgate-on-Sea, Kent. K 851

TENDERS.

COUNTY BOROUGH OF ST. HELENS.

ELECTRICITY DEPARTMENT.

Tenders are Invited for the

SUPPLY, DELIVERY and ERECTION of ONE DOUBLE GIRDER, HAND OPERATED, OVERHEAD TRAVELLING CRANE, of normal lifting capacity of Five Tons.

Copies of the Specification may be obtained from the undersigned.

Tenders, duly sealed and endorsed "Tender for Overhead Crane," should be addressed to—

THE CHAIRMAN,
Electricity Committee,
Electric Power Station,
St. Helens,

not later than December 11th, 1920.

B. T. HAWKINS,
Borough Electrical Engineer.

St. Helens.
24th November, 1920. K 921

GREAT NORTHERN RAILWAY (IRELAND).

SECOND-HAND MACHINERY FOR SALE.

The Directors are prepared to receive

Tenders for the Purchase of the

following SECOND-HAND MACHINERY—

Two Vertical Engines, in complete working order, suitable for Driving Workshop Shafting.
One Small Punching and Shearing Machine.
One Steam Crane (to lift 1½ tons).
One Hydraulic Accumulator and Pump.
One Wheel Lathe (to take 5 ft. 6 in. dia. wheels).
One Screwing Machine (to screw ½ in. to 1 in.).

The Machinery can be seen at Dundalk Works, on application to the Company's Locomotive Engineer, Dundalk.

Tenders, made out on forms supplied by the Company, should be delivered under sealed cover, endorsed "Tender for Machinery," to the undersigned, not later than 10 a.m. on the 13th December, 1920.

The Directors do not bind themselves to accept the highest or any tender.

J. B. STEPHENS,
Secretary.

Amiens Street Station, Dublin,
23rd November, 1920. K 902

LONDON COUNTY COUNCIL.

The Council invites

Tenders for the Removal and

DISPOSAL OF ASHES from its Power Station at East Greenwich, for alternative periods of six and twelve calendar months, commencing 1st February, 1921.

Particulars and forms of tender may be obtained from the GENERAL MANAGER, London County Council Tramways, 22, Belvedere Road, Lambeth, S.E. 1.

No Tender will be considered if received at County Hall, Spring Gardens, S.W. 1., after Twelve noon on Tuesday, 14th December, 1920.

The Council does not bind itself to accept any Tender.

JAMES BIRD,
Clerk of the London County Council.
K 835

CRICKLADE & WOOTTON BASSETT RURAL DISTRICT COUNCIL. (WILTS)

WOOTTON BASSETT SEWERAGE AND SEWAGE DISPOSAL WORKS.

GENERAL CONTRACT NO. 1.

The above Council invite

Tenders from Responsible

Sewerage Contractors for these WORKS, which comprise the Construction of Screening and Detritus Chambers, Sedimentation, Upward Flow, Storm and Humus Tanks, Bacteriological Filters, Engine House, Engine and Pump, Fine Grain Filters, New Outfall Sewer, Relief Sewers and Alterations and Additions to Existing Sewers, Surface Water Drains, Ventilating and Flushing Arrangements, and other Incidental Work.

The Contract will be let on the basis of a FIXED PROFIT and FIXED SUM for Administrative and Establishment Charges, and for the Supply and Use and Waste of all Plant.

The Contractor whose Tender is accepted will be required to find two Sureties to the satisfaction of the Council, to join him in a bond for the sum of £2500 for the due performance of the work.

Plans may be seen, and a copy of the Specification Bills of Quantities, and Form of Tender may be obtained from the Council's Consulting Engineer, Major T. J. Moss FLOWER (of 28, Victoria Street, Westminster, and Carlton Chambers, Baldwin Street, Bristol,) at his Bristol Office, on and after December 2nd, 1920, between the hours of 10 a.m. and 4 p.m., on payment of a deposit of £10 Bank of England note, which will be refunded provided a bona fide Tender be received and is not withdrawn before the sealing by the Council of one of the Tenders, and provided that any documents supplied be returned to the Engineer.

On production of a receipt for the deposit, persons tendering may inspect the plans at WOOTTON BASSETT on a day and at a time and place which will be communicated to them.

Sealed Tenders endorsed "Tender for Wootton Bassett Sewerage and Sewage Disposal Works, General Contract No. 1." are to be delivered at my Office not later than Twelve noon, on Monday, December 13th, 1920.

The lowest or any Tender not necessarily accepted.

By Order,
R. C. HAWKES,
Clerk to the Council.

Council Offices,
Wootton Bassett, Wilts. K 894

ELECTRICITY COMMISSIONERS, VICTORIA, AUSTRALIA.

TENDERS FOR PLANT.

Tenders are Hereby

Invited for the SUPPLY, DELIVERY, etc., of the following PLANT for the MORWELL POWER SCHEME.

Copies of Tender forms, Specifications, Drawings and Conditions, are available at the charges mentioned hereunder, upon application to—

THE AGENT GENERAL FOR VICTORIA,
Victoria House,
Melbourne Place,
Strand,
London, W.C. 2.

Specifications Nos.	Description.
39	25,000-12,500 Kw. Turbo Alternators, 600 Kw. Turbo Alternators Condensing Plant. Circulating Pumps.
33	Transformers and Switchgear for Power House.
41	Synchronous Condensers, Transformers, Frequency Changer and Switchgear, for Newport Terminal Station.
42	Transformers and Switchgear and Accessories for sub-stations C, D, G. and J.

Charge:—Five Guineas for the first three copies of each Specification and 1½ Guineas for each copy thereafter.

34	Copper Cable.
35	Transmission Steel Towers.
36	Suspension Insulators.
37	Aluminium Steel Reinforced Cable.
38	Transmission Steel Towers.
39	Suspension Insulators.
40	Galvanized Steel Cable.
43	Steel Telephone Poles.
44	H.T. Telephone Accessories.

Charge:—Three Guineas for the first three copies of each Specification and one Guinea for each copy thereafter. Specifications 34, 35 and 36 are alternative to 37, 38 and 39. Both sets of Specifications will be issuable for one set of charges.

The Commissioners do not bind themselves to accept the lowest or any Tender.

The Specifications and Drawings may be inspected at the Offices of the Consulting Engineers of the Victorian Government, Messrs. JOHN COATES & Co., LTD., Victoria House, Melbourne Place, Strand, London, W.C. 2.

Tenders on prescribed forms, properly endorsed must be delivered to:—

R. LIDDELOW,
Secretary,
Electricity Commissioners,
673, Bourke Street West,
Melbourne,
Victoria,
Australia,

not later than Noon on 24th February, 1921.

(Signed) PETER McBRIDE,
Agent-General for Victoria. K 910

G. R.

MINISTRY OF MUNITIONS.
BY DIRECTION OF THE DISPOSAL BOARD.
(PLANT & MACHINERY SECTION.)
CRANES.

Sale by Public Tender.

ONE ELECTRIC COAL GRABBING CRANE.
Hammer head type fitted with Hoisting, Traversing, and slewing motions, with all necessary Electrical and Mechanical gear. Grab by Priestman Bros., of 4 rope, centre shaft design.
Grab capacity, Plush 34 cu. ft.
Grab capacity, Heaped 41 cu. ft.
Weight of Grab empty, 27 cwts.
Effective Radius, 85 ft.
Height from Crane Pedestal to under-side of Cantilever arm, 32 ft.
Height of lift, 38 ft. (about).
Lowest Grabbing position below Crane Pedestal, 14 ft.
Current Supply, 440 volt, 3 phase, 50 cycles.
Capable of handling from 20 to 25 tons per hour.
LYING AT: Messrs. Herbert Morris, Ltd. (makers), Loughborough. Reference M.K. 36136.

HAND CRANES AT THE ROYAL MINING DEPOT, IMMINGHAM.

22 Double Girder Morris "G" type, Hand Power Overhead Travelling Cranes. Distance between Rails and Floor 16 ft. Working load 1 ton. Test load 1½ tons. Span between rails 34 ft. 2 in. Reference M.K. 47322-47343.

One ditto as above, but working load 1½ tons. Test load 2¼ tons. Reference M.K. 47344.

Three Hand Travelling Rail Cranes. Single and double purchase lifting gear. Jib of Steel joist, and long enough to give a radius of 15 ft. Under carriage mounted on 4 single flange C.I. Wheels. Will lift working load of 20 cwt. on double gear, and loads up to 10 cwt. on single gear. Working load is 20 cwt., test load 30 cwt. By Carrick & Ritchie, Edinburgh. Reference M.K. 47345-6 and 7.

One Hand Travelling Crane. No gear for slewing motion as Crane can be easily slewed by hand. 4 Carriage wheels, single flange C.I. 2 ft. dia. Radius of Crane is 24 ft. and height from underside of Hook to Crane 24 ft. Rope of flexible wire with factor of safety of not less than 8. Necessary Brakes for lifting and Travelling fitted. Rail gauge 4 ft. 8½ in. Working load 10 cwt. Test load 15 cwt. By G. Russell & Co. Reference M.K. 47348.

Full Specification of Grabbing Crane, detailed particulars of other Cranes, Permits to view, and tender forms can be obtained on application to the Controller,

D.B.I.B.
Charing Cross Huts, W.C. 2.

Tenders to be completed and returned on or before Ten a.m. on the 7th December, 1920. K 647

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EVENING CLASSES.

A Lecturer is Required for

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Applications must be received not later than 4th December. K 833

THE COUNCIL OF THE RESEARCH ASSOCIATION OF BRITISH MOTOR AND ALLIED MANUFACTURERS invite

Applications for the Post of

ASSISTANT DIRECTOR OF RESEARCH.

Applications, with copies of three recent testimonials, should be posted as soon as possible to the R.A.B.M.A.M., Room 438, Ulster Chambers, Regent Street, W. 1, and the envelope marked "Candidate." Engineering experience, scientific training and brief sketch of career should be given. No one without first-class scientific qualifications should apply. State salary expected. K 655

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FALMOUTH DAY CONTINUATION SCHOOL.

Wanted, Immediately, Assis-

TANT MASTER, specially qualified in Applied Mathematics and Engineering.

Salary according to qualifications and experience (Burnham Scale).

Applications, with copies of three recent testimonials, should be sent to the HEADMASTER, Day Continuation School, Falmouth.

Education Department, County Hall, Truro.
30th November, 1920. K 859

UNIVERSITY OF LONDON.

KING'S COLLEGE.

The Delegacy Require the

SERVICES of a DEMONSTRATOR in Civil and Mechanical Engineering; Salary, £310 per annum, with possible additional emoluments. The duties will commence on January 12th, 1921. Opportunities will be given for research work.

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Clerk Required by the

GOVERNMENT OF UGANDA for the PUBLIC WORKS DEPARTMENT, for a tour of 30 to 36 months' continuous residential service. Salary £360 per annum rising by annual increments of £15 to £460 per annum, payable locally in rupees at 10 to the £, with an additional allowance of 50 per cent. Outfit allowance of £30 on first appointment. Quarters free of rent, and free passages. Liberal leave in England on full salary. Candidates, preferably single, age 23 to 40, should be proficient in shorthand and typewriting and have had experience in an Engineer's office, preferably in that of a Municipal or County Engineer. They must have served in some branch of His Majesty's Forces during the late War, unless their reasons for not having done so are entirely satisfactory. Apply at once, by letter, stating age, whether married or single, and giving full particulars of experience to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/10687. K 915

The Bennett College have

VACANCIES for ASSISTANT TUTORS in the following departments—Chemistry, Metallurgy, Engineering and will be pleased to receive applications from gentlemen with qualifications.—Address letters "Private," THE GOVERNORS, The Bennett College, Sheffield. K 863

Wanted, Experienced and

Well-qualified WHOLE TIME TEACHER of METAL WORK and MECHANICAL ENGINEERING SUBJECTS. Commencing salary £300 to £350 per annum including bonus. For full particulars and application Form send stamped addressed envelope, to J. EAGLES, A.R.C.Sc., Principal, Technical College, Doncaster. K 866

PORTSMOUTH MUNICIPAL COLLEGE.

Principal: OLIVER FREEMAN, Wh.Sc., A.R.C.S., B.Sc.

Applications are Invited for

the following APPOINTMENTS:

(1) LECTURER IN ENGINEERING.
(2) LECTURER IN ELECTRICAL ENGINEERING.

Salary Scale under revision. Candidates should state the initial salary required.

Further particulars and Forms of Application may be obtained from the undersigned, to whom applications should be returned at once, accompanied by copies of not more than three recent testimonials.

H. E. CURTIS,
Secretary.
23rd November, 1920. K 897

UNIVERSITY OF HONG KONG.

Two Lecturers in Mechanical

Engineering are REQUIRED for the University of Hong Kong. Five years' agreement; salary £600 per annum, converted for purposes of local payment at 2/- to the dollar, free quarters or allowance of £100, half salary from date of embarkation. Candidates should be graduates in Engineering of some British University and preferably unmarried.

Applications should be submitted (not later than December 13) in covers marked "C.A." and addressed to the SECRETARY, BOARD OF EDUCATION, Victoria and Albert Museum, South Kensington, S.W. 7. Scottish candidates should apply to the SECRETARY, SCOTTISH EDUCATION DEPARTMENT, Whitehall, London, S.W. 1. K 776

UNIVERSITY COLLEGE, JOHANNESBURG.

The Council Invites

Applications for the following

APPOINTMENT:

JUNIOR LECTURER AND DEMONSTRATOR IN THE DEPARTMENT OF MECHANICAL ENGINEERING.

Applicants must have had technical training, workshops, and preferably also drawing office experience. Salary £354 per annum, rising by £37 10s. annually to £464. War bonus at Government rates; at present £26 per annum for single man, £114 if married. Appointment probationary for first two years. Applicant with special qualifications may possibly be appointed at higher rate than specified. Duties commence about 1st March, 1921. Allowance for travelling expenses £40. Half salary from sailing until arrival. Medical certificate required before appointment. Age to be stated. Applications and testimonials, all in triplicate, to be sent by 6th December to CHALMERS, GUTHRIE & Co., LTD., 9, Idol Lane, London, E.C. 3. K 639

CHESHIRE COUNTY COUNCIL. EDUCATION DEPARTMENT.

NORTHWICH VERDIN TECHNICAL SCHOOL AND SCHOOL OF ART.

Principal: D. N. GRIFFITHS, B.Sc., A.M.I.Mech.E.

Applications are Invited for

the undermentioned POSTS:—

1. PRINCIPAL of the above-named School and Headmaster of the Voluntary Day Continuation School connected therewith. Candidates should possess a good degree in Engineering or an equivalent qualification. Inclusive annual salary £550–£25–£700.
2. FULL-TIME ASSISTANT in the Engineering Department, mainly to teach Workshop Processes. Annual Salary £300–£25–£450.

Forms of Application and further particulars may be obtained from the undersigned.

C. F. MOTT,
Director of Education.

County Education Offices,
City Road,
Chester. K 901

CRICKLADE & WOOTTON BASSETT RURAL DISTRICT COUNCIL (WILTS.)

WOOTTON BASSETT SEWERAGE & SEWAGE DISPOSAL WORKS.

CLERK OF WORKS.

(To commence duties at an early date.)

The Council invite

Applications for the above

APPOINTMENT. Candidates must be thoroughly experienced in the Construction of Modern Sewage Disposal and Drainage Works, and able to efficiently discharge the duties required of Clerk of Works on works of this kind, and must be competent with the use of the Level and Theodolite and be able to Set Out and Measure Up Works and Keep Accounts, etc.

No others need apply.

The Clerk of Works will be required to act under the direction of Major T. J. Moss FLOWER, the Council's Consulting Engineer.

Salary £7 7s. per week. No out-of-pocket expenses will be paid.

Time. About ten months, subject to approved service.

Applications, marked "Clerk of Works" stating any previous experience, and enclosing copies of three recent testimonials, to be sent direct to the ENGINEER at his Bristol Office, Carlton Chambers, Baldwin Street, Bristol, so as to reach him not later than Noon on Thursday, December 9th, 1920.

H. C. HAWKES,
Clerk to the Council.

Council Offices,
Wootton Bassett, Wilts. K 898

NATIONAL PHYSICAL LABORATORY TRACTION DYNAMOMETER FOR AGRICULTURAL TRACTORS.

By J. H. Hyde, A.M.Inst.C.E., M.I.A.E., A.M.I.M.E.

In the summer of 1919 the Laboratory was approached by the Society of Motor Manufacturers and Trades with a request for assistance in the recording of draw-bar pulls of agricultural tractors at Lincoln in September, of that year, on the grounds that no suitable British-made draw-bar provided with recording apparatus was available for the purpose. It was required that the draw-bar in these trials should be attached to the forward turntable of an ordinary road trailer which would be loaded and braked on the rear wheels in order to provide sufficient road resistance to enable the maximum draw-bar effect of the tractors to be determined. In the arrangement adopted the pull of the tractor was transmitted through a bell-crank lever to a leather diaphragm fitted to a box containing water. The diaphragm box was connected by a flexible pipe to a recording pressure gauge actuating a pen. The motion of the recorder paper was produced by means of gearing from the front wheels of the tractor.

In the present year the Laboratory received a similar request from the Royal Agricultural Society of England in conjunction with the Society of Motor Manufacturers and Traders in connection with the measurement of draw-bar pulls and speeds of tractors under ploughing conditions at the trials to be held at Lincoln in September-October, 1920. The Executive Committee of the Laboratory agreed that all possible help for the successful carrying out of the trials should be given by the engineering department, and a special dynamometer was designed and constructed at the Laboratory for the purpose.

The design of the instrument was influenced by the necessity of producing a dynamometer which would be capable of measuring and recording the draw-bar pull and speed of a tractor engaged in ploughing, special consideration being at the same time given to the fact that it was undesirable to separate the tractor and plough by apparatus which would in any way interfere with the proper working of the plough or with its control by the tractor driver.

For the purpose of competitive tractor trials, the dynamometer would be required for use with many different makes of tractors and ploughs, and it could not be guaranteed that a suitable position for apparatus could be provided on either; further it was desirable that the dynamometer should be capable of being quickly attached to or detached from one tractor and transferred to another. In consideration of these requirements it was decided to separate the dynamometer proper from the recording instrument and to place the latter on a light-wheeled carriage which could be either wheeled or towed alongside the tractor under test.

The Dynamometer.—An elevation and section of the coupling between the tractor and plough are given in Figs. 1 and 2. It consists of a cylinder and plunger, the former being attached to the draw-bar of the tractor and the latter, through links, to the plough. The pull on the coupling sets up a pressure in the oil confined in the cylinder, and this pressure is transmitted to a recording pressure gauge by a flexible hydraulic tube. The best flexible tube which could be obtained would safely withstand an internal pressure of 1 ton per square inch without reduction of flexibility, and as the dynamometer was required for pulls up to 3 tons, a diameter of plunger of approximately 2 in. was, therefore, necessary.

The cylinder was made of steel and the plunger of bronze, the clearance between the two was made 0·001 in., and the plunger was provided with a very thin packing ring of oiled leather. In order to avoid a gland the draw-bar pull was converted to a thrust on the plunger by means of the links L, L, and the pins P_1, P_2. The thrust on the plunger is transmitted through the second plunger E, which is suitably guided in a continuation of the cylinder, and the connection between the two plungers is a loose one in order to allow the larger plunger to float freely in its cylinder. The pin P_1 passes through the slots in the guide-piece.

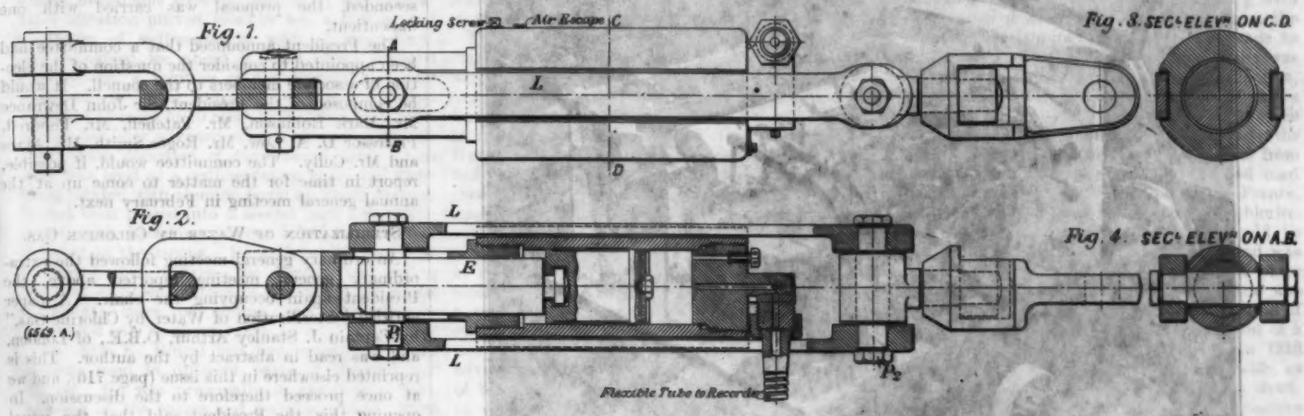


Fig. 5.

The connection to the tractor draw-bar was made in such a manner that the cylinder could not rotate, but the opposite end of the dynamometer was provided with a swivel attachment for the plough. A rubber cover over the front portion served to exclude dust and grit from the interior of the cylinder.

The Recording Instrument.—The recording instrument was mounted on a two-wheeled carriage which was towed by the tractor, a suitable hitch being made to prevent damage to the connecting hydraulic tube. Fig. 5 shows the general arrangement of the carriage and Fig. 6, page 694, of the recorder. The latter consists of a standard Schaffer and Budenberg pressure recorder considerably modified for the present purpose by the addition of a second Bourdon tube, a clock, and paper driving device. The recording paper is driven through gearing and a chain drive from one of the carriage wheels, and three speeds of the paper are provided for, namely, 1 in. of travel to 100 ft.; 50 ft. or 10 ft. motion of the carriage over the ground. The speed-change can be made while running if desired. As the recorder proper rests on thick felt pads, the final drive is made by means of a leather vee belt adjustment of the tension of which is provided for. The hydraulic tube from the dynamometer is connected to a small valve-box V, Fig. 5, by which the pressure can be diverted to either of two Bourdon tubes, 1 and 2, shown in Fig. 6.

The motion of the end of each Bourdon tube is magnified by the pen mechanism 4, which is such that the travel of the pen is 4 in. for a maximum draw-bar pull of 4,000 lb. using tube No. 1, and 3½ in. for a maximum pull of 7,000 lb., using tube No. 2. The pen mechanism can be transferred to either tube by transferring the screw 7, which forms the link pivot; the change can be effected during a test if required.

A clock 3, shown in Fig. 6, is provided for indicating time on the record paper. An electrical contact is made at equal pre-determined intervals of time which can be varied from 2 seconds to 6 seconds, and the pen, 5, which normally draws a straight line, is momentarily moved to one side when the contact takes place. A robust escapement for the clock is

provided, and was found in practice to work extremely well, there being no apparent variation in the time intervals recorded, or in the total time even when the carriage was travelling over very rough ground and subject to much shock. In order that the number of time intervals indicated may be readily counted, every fourth contact is missed. This will be seen in Fig. 7. Pen 6 is provided for recording revolutions of the tractor engine, or of the tractor driving wheels, and is identical with pen 5.

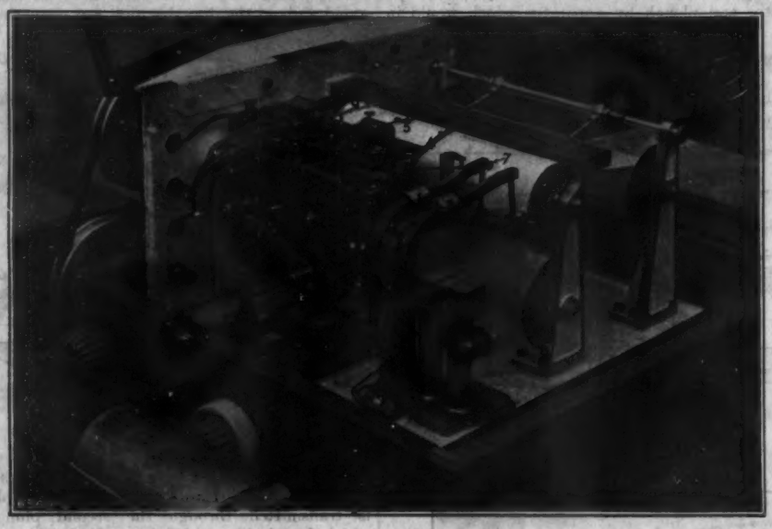
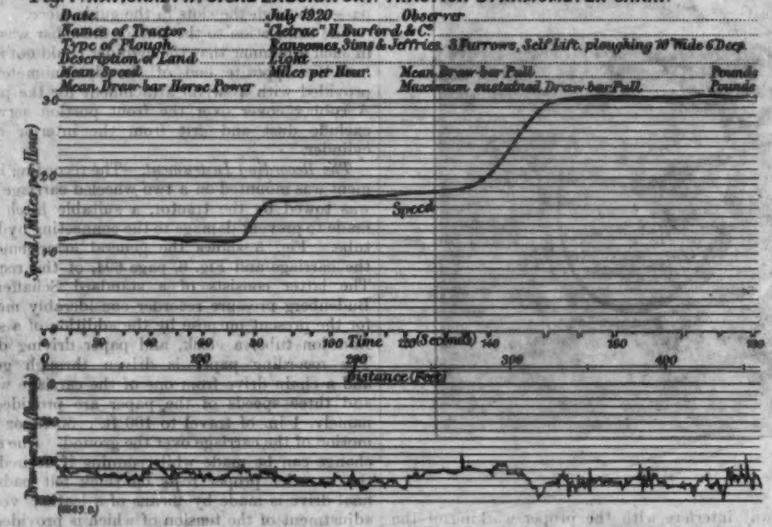


Fig. 6.

Fig. 7. NATIONAL PHYSICAL LABORATORY. TRACTION DYNAMOMETER CHART.


Date July 1920 Observer
Names of Tractor "Clitrac" H. Burford & Co.
Type of Plough Ransomes, Sims & Jeffries. 3 Furrows, Self Lift, ploughing 10" Wide 6 Deep.
Description of Land Light
Mean Speed Miles per Hour. Mean Draw-bar Pull. Pounds
Mean Draw-bar Horse Power Maximum sustained Draw-bar Pull. Pounds
Speed (Miles per Hour)
Speed
Time (Seconds)
Distance (Feet)

An oil pump, taking oil from a small reservoir placed under the carriage, serves to prime the dynamometer and recorder. This pump is shut off when the apparatus is working. It will be observed that the measured distances on the chart between indications of equal time intervals are directly proportional to the speed because the travel of the paper is proportional to the distance travelled. The average speed for any interval of 5 seconds can, therefore, be readily obtained, and the curve of speed plotted on the chart. When the speed is low, and variable, this method for recording is preferable to using a centrifugal instrument.

Calibration.—The apparatus was calibrated by direct loading. The dynamometer coupling was hung from a crane hook and supported a cradle carrying a dead load which was increased by 500 lb. at a time. The indications of both pens were taken in turn and were found to agree precisely with those obtained by calculation from the oil pressure and the sectional area of the cylinder. When the load was 2,000 lb. a shift of the pen point of 0·01 in. could be clearly seen due to a gently added load of 10 lb. It was necessary to provide a small tapping device, consisting of the essential parts of an ordinary electric bell, to free the pen mechanism in order to enable it to record so small a load, but it was not necessary to use this during a test because the motion of the recorder carriage itself provided sufficient vibration for the purpose. The calibration left no room for doubt that the friction of the packing leather of the plunger in the dynamometer cylinder was small enough to be neglected. The sensitivity did not appear to be materially affected by the use of thick oil in the cylinder, and consequently for ploughing tests on stony ground or stiff land where the pull is very variable, it is advisable to use thick oil in order to damp the vibrations of the recording pen. Fig. 7 is a specimen of the dynamometer chart, reduced in size, obtained from a track-laying machine drawing a three-furrow plough in light loamy soil.

In this test the speed of the tractor was purposely varied in order to ascertain the variation in drawbar pull. The chart indicates an increase in draw-bar pull from 1,150 lb. at 1·2 m.p.h., to 1,250 lb. at 3·05 m.p.h. The speed curve has been plotted from the time intervals and distance recorded.

THE INSTITUTION OF MECHANICAL ENGINEERS.

A special meeting of the Institution of Mechanical Engineers was held at Storey's Gate on Friday last to confirm the alterations in the bye-laws which had been considered at the meeting on October 22. These alterations were concerned chiefly with the constitution of the council, and the institution of a grade of past vice-presidents. The President, Captain H. R. Sankey, C.B., was in the chair. The bye-laws in their new form having been read by the secretary, it was proposed by the President that they should be adopted. This having been seconded, the proposal was carried with one dissentient.

The President announced that a committee had been appointed to consider the question of the election of associate members to the council. It would be composed of the President, Sir John Dewrance Mr. Mark Robinson, Mr. Patchell, Mr. Pendred, Professor D. A. Low, Mr. Roger Smith, Mr. Ayres and Mr. Cully. The committee would, if possible, report in time for the matter to come up at the annual general meeting in February next.

Sterilization of Water by Chlorine Gas.

An ordinary general meeting followed the extraordinary general meeting reported above, the President again occupying the chair. A paper entitled "Sterilization of Water by Chlorine Gas," by Captain J. Stanley Arthur, O.B.E., of London, and was read in abstract by the author. This is reprinted elsewhere in this issue (page 716), and we at once proceed therefore to the discussion. In opening this, the President said that the actual sterilization of water did not concern the mechanical engineer, but the latter must know the principles upon which it was carried out; otherwise he could not appreciate the machinery used.

Dr. S. Rideal, F.I.C., who followed said he regretted the absence of Sir William Horrocks, who probably knew more than any one about the sterilizers used during the war. Chlorine had, of course, been used, for sterilizing water, long before the Boer War, as had also bromine to which the author referred. Some of the earlier work had even been done before the Hamburg epidemic, fifteen years previous to the Boer War. The first practical use of chlorine for water purification on a large scale was made on the occasion of the Maidstone epidemic in 1897. In 1905, during the Lincoln epidemic, chlorine was used to sterilize the water supply. At Philadelphia, in 1912, he had seen Major Tiernan's apparatus, the first practically successful in using chlorine as apart from bleaching powder. The advantages of chlorine over bleaching powder were obvious. Chlorine in an acid condition was the most effective germicide known, but bleaching powder was alkaline, and was not so energetic in destroying organic matter until the chlorine in it had been liberated by means of an acid. In addition to liquid chlorine, liquid bromine had also been used by the German Army for sterilising purposes as far back as the 'eighties and 'nineties. The method was simple, the liquid bromine being carried about in little glass bulbs and put into the water. There was no novelty therefore, in using bromine for sterilisation. Bromine and iodine and chlorine had germicidal action proportionate, roughly, to their atomic weights, or about in the proportions of chlorine 24, bromine 64, and iodine 100. The after-taste of the water was important. With either bleaching powder or chlorine in excess, the taste would be affected. This could be neutralised by sulphurous acid, but it was not altogether satisfactory. This acid had to be carried about in a cylinder, like chlorine, and a similar dosing arrangement was necessary, and, to ensure the destruction of organic matter an "excess" of sulphurous acid was necessary, which led to the consideration of something which would remove the sulphurous acid. Of the materials tried for this, Dr. Rideal considered the most useful to be hydrogen peroxide, potassium or sodium permanganate. The permanganates were the common reagents used for "pinking" wells during the last fifty years, and had an excellent effect on removing the after-taste of chlorine.

Major-General Sir William Liddell, speaking as

a user of the chlorine plant described, explained that at one time water had been required for some 20 divisions in Belgium, where the water was very foul. For a rapid advance, which however did not take place, dependence was placed on the water canals, early forms of the plant being placed on barges. Motors had also to be provided for the sterilizing plant, the output of which was gradually increased from 400 gallons to 1,200 gallons an hour. The plant had proved useful in every way, and its use had spread through the armies. The lorries, indeed, had saved the troops from retirement in many tight places. The River Yser was one of the foulest imaginable streams, judging by the intakes. Sand filtration proved more or less a failure, and a system of sedimentation with alumino ferric was employed for about 8 hours; then followed chlorination, a solution of the bleaching powder being added. That water was eventually pumped up about 15 miles or 20 miles to the front. In 1918, during the later advance, a portable apparatus was used which consisted of two canvas tanks. One tank was used as a sedimentation tank, the water being treated with alumino ferric for about 8 hours. It was then passed into a second tank and chlorinated, with bleaching powder solution; and distributed to the troops. He believed he was right in saying that whereas the French had during the first eighteen months of the war, some 60,000 or 80,000 cases of enteric, the British cases amounted only to about 1,000.

Dr. Eric K. Rideal had had experience of the systems used in different parts of Belgium and France. He was principally in the Somme area, working on the barges and portable plants. With regard to direct dosage, there were two types of apparatus, one, the Wallace and Tiernan, in which the chlorine was passed straight into the water, and another type, in which a certain volume of water was chlorinated and then added to the main bulk. An interesting problem was the measurement of the chlorine. The meters in use were of three types—the Venturi, the pulsing and the electric flow. The last-named, which measured the loss of heat in a wire maintained at a certain temperature in a current of gas, had been applied successfully to measuring other gases, but not chlorine; but there was no reason why it should not be applied to chlorine. For the measurement of very small quantities of chlorine great accuracy was needed in the measuring instruments. The Venturi meter was divisible into two types, one of them the pin-hole orifice meter and long tube, was very sensitive to temperature changes, &c. The orifice type was to that extent not a good one. The pulsing meter was preferable, since there were no very small contractions. He considered the electrical resistance type could be elaborated into a very serviceable mechanical outfit.

The next point was how to measure the quantity of chlorine left in the water after a time. This was usually done by titration. There were certain interesting electrochemical facts relating to the action of chlorine on water. He had obtained the oxidation potentials in both acid and alkaline water, the figure for the former being 1·39 and for the latter 1·86. In acid solution, chlorine was nearly as strong as potassium permanganate as an oxidising agent. The thing desired was to be able to measure the oxidising potential. An apparatus had been devised having a platinum wire in a copper tube. On passing a little water through, this acted as a little battery, and the quantity of current flowing could be measured with a suitable device. That would give the quantity of chlorine in the water as measured in terms of its oxidising power. In France the water was always varying in chlorine absorption, and it was necessary to test frequently with potassium iodide and starch to avoid risks to life. The electrical method of measuring chlorine had been useful. The after-taste in chlorinated water was extraordinary in the case of animal pollution, but was much less marked with vegetable pollution; with the latter chlorine absorption was greater. The reason was not quite clear.

Mr. William Patterson agreed that the initiation of the process of gaseous chlorine should, to a large extent, be credited to America. In 1897, at Maidstone, hypochlorite of lime was used simply for flushing at the mains and ensuring disinfection of the latter. That could not be considered as disinfection of the drinking supply. Professor Sims Woodhead had said that the whole of the water mains from the gravitation reservoir had been cleaned out with a powerful solution of bleaching powder. That was really a powerful disinfection, not sterilization. He thought the author should have referred to the classic research of Houston and McGowan (Fifth Report of the Royal Commission on Sewage Disposal), a research which determined, he believed for the first time, the amount of chlorine absorbed by water of a given impurity, while the report also dealt with the effect of sunlight on chlorine sterilised water and of chlorinated water on slow sand-filter beds.

The author had made no mention of the first suggestion that gaseous chlorine should be used for sterilizing water supply. The idea did not originate in America, but with an officer of the Indian Medical Service, Lieutenant (now Major) Nesfield, in 1903. In a paper on "A Chemical Method of Sterilizing Water without Affecting its Potability," Nesfield had advocated the use of a portable gaseous chlorine plant, and gave the result of actual tests with the reagent; further, he had suggested dechlorination with sodium phosphate. Virtually this was the process brought to a practical success by Darnall, in 1912, and also by Ornstein. In 1913, Ornstein took out a patent for his apparatus, which embodied a gaseous chlorine cylinder, automatic means for regulating the supply of chlorine and ratio of flow through the Venturi tube; altogether a great advance on Darnall's proposal. On the question of taste, if hypochlorite were added as accurately as chlorine the speaker considered there would be no difference of taste. Dechlorination did not remove the taste if the taste were due to the reaction of the chlorine with the organic matter in the water. The only method of removing the taste was that referred to by Dr. Rideal and suggested by Houston in his report to the Metropolitan Water Board (Thirteenth Research Report).

Mr. Paterson then proceeded to explain an apparatus which he exhibited, in which the compressed chlorine gas passed through two reducing valves, which brought down the pressure from, say, 150 lb. (pressure being according to temperature) to, say, 30 lb. per square inch. The gas then passed through a regulating valve and through a meter U-tube to the absorption tower. A trickle of water absorbed the chlorine gas. A special feature of the arrangement was the complete isolation of the mechanism from the water by a column of liquid infected by the chlorine gas. By no chance could the moisture get back into the mechanism. The column of liquid was used to meter the flow of gas. The apparatus had been in use for some years at various stations of the Metropolitan Water Board. Mr. Paterson then described a typical plant of this Board, and showed lantern slides to explain its chief features. He described one of the pumping stations on the New River, and explained how the chlorine flowed through a U-shaped pipe fitted with orifices laid under water in the New River. The arrangement for distribution of the chlorinated water was indicated, a large number of nozzles being utilised. Thirty-six gas cylinders were employed coupled up to the metering arrangement measuring the flow of the gas, which was carried to the top of the tower. A small flow of water absorbed the chlorine.

Mr. V. Hjort followed, and remarked that the author had evidently concentrated more on the portable arrangements for use by troops than on the general sterilisation of water for municipal purposes. For stationary work, ordinary bleaching powder was used with success, and continued to be used throughout the war. Mr. Hjort showed a series of lantern views to explain the development of the portable type of plant, beginning with the more primitive apparatus, in the way of lorries, &c. We regret that we are unable to reproduce the views shown; they indicated certain steps in the progress of portable water-sterilising equipment from 1910 on. Mr. Hjort considered that as regards the general question of water sterilisation the Americans were ahead of this country in the chlorination of water, particularly the use of chlorine gas, their largest plants dealing with 280,000,000 gallons per day.

Captain R. W. Stickings, O.B.E., speaking as a chemist, observed that he had mobilised the first unit and taken it out to France, this unit being in working condition up to the time of the armistice. During that period he had under his control 30 lorries. The 30 lorries delivered altogether about 60,000,000 gallons of sterile water to the troops. On one occasion it had been possible to get one of the sterilisers into position within 24 hours of the occupation of a certain village—a big job, with 8-ton or 9-ton lorries travelling on a road blown to pieces by shells. The introduction of chlorine gas led to an effort to centralise supplies. The cost of chlorinators was a very large item in dealing with army supplies of water. In order to minimise the number of chlorinators, an attempt was made to chlorinate the water at the source, but difficulty was experienced owing to the fact that the chlorine, attacking the inside of the pipes—some 10 miles or 12 miles of line—did not come through to the far end. Captain Stickings explained that the French system of chlorinating was different from the British, but very successful and he had used it himself in a few stationary plants in France. The water was sterilised by sodium hypochlorite. This liquid, which was perfectly clear, could be bought at most of the paraffin-oil shops, and was used as a sterilising agent in bad areas. The water simply passed through the main, and a little was taken off, by means of a by-pass, through a kind of filter pump, which sucked in a certain amount of a strong solution of sodium hypochlorite. In 1916 the idea of dechlorinating was dispensed with, as it was found to be unnecessary, and even detrimental, because, unless a half to three-quarters of the chlorine was left in the water, it was almost certain that by the time it reached the people it was no longer sterile.

Mr. William H. Patchell said that on the occasion of a recent visit to Detroit he got into touch with the water works engineer (Mr. Teisen) and endeavoured to get some particulars of the chlorination system used there. The engineer very kindly showed him the plant. The chlorine cylinders were put on a large weighing machine, the chlorine being bubbled into water at a steady pressure of 10 lb. The water was then run into a large settling tank, pumps drawing the water from the settling tank and delivering it into the town. There were some 1,500 miles of mains, 65 miles of which were from 42-in. to 48-in. in diameter. There was a good chance therefore of any slight error averaging out. He had lost all sense of taste or smell of the chlorine in the water after about 10 days in Detroit. The supply in Detroit amounted to 150,000,000 gallons a day—about 150 gallons per head. In another water works handling about 750,000 gallons a day, the water was kept free from taint by the same chlorine gas; in both cases the water was taken from the Detroit River, more or less muddy. In Detroit they were at present arranging to put down filter tanks, having only the settling tanks of which he had spoken. It was an interesting point to note that wooden water pipes were used. He was reminded, in this connection, when looking with a friend over a volume of drawings of Leonardo da Vinci, that he had seen among these drawings a machine for boring out wooden water pipes.

Mr. W. C. Bouts asked the author how he knew when water was sufficiently sterilised; also how much chlorine was required to sterilise a given amount of water.

Mr. W. H. Patchell, speaking again, said that a copy of Messrs. Wallace and Tiernan's catalogue referred quite frankly to early British work, instancing that of Dr. Houston as the first large-scale attempt to sterilise water by the process of chlorination.

Mr. A. W. Marshall asked the author what he meant by "metallic poisoning" in connection with water supply at the front.

Mr. W. J. Butterfield referred to experience in Mesopotamia, where a large number of deaths had been due to the chlorination of the water not being properly carried out. In the Kut relief expedition, the speaker's chief laboratory assistant, Captain F. L. Bassett, B.Sc., had been detailed by the medical officer to take charge of the sterilisation of the water supply there. He had set to work with an improvised barrel as a churn, using the only

available material, *i.e.*, chloride of lime. Shortly afterwards the chlorine driven off from the chloride of lime by an acid was used. A standard solution of strong chlorinated water was then made up, put into bottles, and sent up river with instructions that one bottle would sterilise so many gallons of river water, the proportion varying with the time of year. From that time forward there was little or no water-borne disease in the area. Captain Bassett was now chief chemist to the Civil Administrator of Mesopotamia, Headquarters, Baghdad. Referring to the remark of the author relative to brominated water, the speaker pointed out that Germany was the only source of bromine or bromine compounds in the world.

Lieutenant-Colonel A. E. Davidson stated that his experience was confined to the type of plant carried on motor lorries. Four M.T. companies were concerned with the purification of the water, two using bleaching powder and two using chlorine gas. The great increase in capacity of the sets—400 gallons to 1,200 gallons an hour—was almost a drawback, inasmuch as some of the places where the sets were required had relatively small sources of supply, making the application of a 1,200-gallon set wasteful. Another objection, from the mechanical transport point of view, was the rather excessive weight of the lorries; some of the heavy parts, moreover, came almost behind the back axle. He was therefore glad that a lighter type, making the plant more portable for army use, had been evolved (see Fig. 9 in the paper). A number of the lorries carrying bleaching powder sets had to be converted for the transport of chlorine gas.

Captain J. Stanley Arthur then replied to the discussion. The case for dechlorination with sulphur dioxide was scarcely as Dr. Rideal had put it. In the Army it had always been necessary to leave some chlorine in, to ensure the sterility of the water. It was accordingly unnecessary to add excess of sulphur dioxide to remove the chlorine. By a simple chemical test, the amount of chlorine liberated could be determined to 0·1 of a millionth part in less than half a minute. Dr. Eric Rideal had referred to the trouble experienced with the Venturi type of meter with the small orifice. This was due to a curious condensation on the glass, which could readily be removed by carbon tetrachloride or, better still, alcohol. In France, every lorry had been equipped with a spare orifice, and a spare scale, and any man with experience could make the change in two or three minutes. The plants were designed for active service, and it was not easy to manipulate delicate electrical instruments with troops in actual warfare. Speaking as a chemist, he considered that the water supply of Maidstone was really sterilised. Turning to the question of the canal water upon which he had worked, this was so filthy as to require three parts per million of chlorine to sterilise it. The amount used at Maidstone left enough chlorine in the pipes of the water-supply system to sterilise the water for some time. The Americans were certainly ahead of British practice; they had been at work a long while, and had been compelled to be so, primarily because their water sources were always polluted. At the time the speaker started work there was, he believed, no other chlorinator in existence which would do what was required.

When demonstrating, at Abbeville, with the first machine, a most objectionable smell like iodoform was experienced, and he had developed extraordinary theories in relation to it, until next day he traced it to the washing of an ambulance a little above his intake. Where the water was bad to work upon—stagnant, or sewage, or very foul—it was impracticable to remove the whole of the taste, but in working on water like that at Richmond, there was no taste of chlorine, if the sterilisation was carried out properly and the chlorine removed by means of sulphur dioxide. Mr. Hjort had been associated with the companies which carried out the portable work for the War Office, and which had also carried out certain stationary and barge plants. Mr. Hjort had placed at the disposal of the War Office a station, and the War Office worked in conjunction with his firm. The chlorinating tests were first of all carried out on a plant composed of old tanks and an old engine, and from this plant actual results were obtained, some of which were set out in the appendix to the paper. It was then suggested that the plant might be mounted on a lorry. Later, the speaker suggested to Sir Wm. Horrocks that the size of the plant might be increased without adding very much to the weight; this was done; a new engine and pumps being used, supplied by United Water Softeners, Limited.

For many years bleaching powder had been injected into water under pressure, but it was not easy to measure the amount of the injection but the methods were inaccurate. The plant he was discussing was fitted for sterilising by chlorine gas with dechlorination by sulphur dioxide gas and also for bleaching powder with dechlorination by sodium bisulphite. This plant was taken to France, where within a week the bleaching powder part was scrapped. The original apparatus had been greatly improved, though the weight remained the same, and was even slightly increased by enlargement of the chamber in which contact took place. The actual weight was about 8 tons 5 cwts., including a good deal of stores. At a later period the weight was still further reduced, to about 4 tons 4 cwt.

In reply to questions relative to the chemical aspect of the matter, "metallic poisoning" might be due to the presence of any metallic substance—such as copper sulphate, mercuric chloride, potassium cyanide, &c.—which could be dissolved in water. That was part of the problem worked at by Professor H. B. Baker and Sir Wm. Horrocks, in association with three chemists, and the performance of the machines to which he had referred in the paper was to remove the whole of the poison from water and render it a perfectly safe drink. Colonel Davidson had alluded to the size of the lorries, and the speaker would say that the reason for increasing the size was connected with the safe transport of troops, but, as he had said, weight and size were ultimately reduced by about 50 per cent., although the output was only reduced from 1,200 gallons to 1,000 gallons.

The President then announced that a further discussion of the paper would take place in Manchester on Thursday, the 25th inst., in the Engineers' Club; also, that an extra meeting would be held in London on December 3, when the paper entitled "The Human Factor in Industry" read at the Lincoln summer meeting, would be further discussed. The proceedings then terminated.

THE GERMAN IRON FOUNDRY ASSOCIATION.—The Verein Deutscher Eisengiessereien celebrated its fiftieth anniversary last October by a four days' meeting at Dresden. In opening the proceedings the president, Dr. Werner, stated that all the German foundries had now joined the association, and that everything should be done to reduce the consumption of coal and materials to the lowest possible limits while trying to raise the quality more and more. The association was now buying up all available scrap; owing to the depletion and deterioration of the German railway stock since the war the scrap question had become serious. How these scrap materials are re-melted in furnaces with the aid of ferro-silicon was explained in one of the papers by G. Sohury; the low-grade ferro-silicon is briquetted, though this is only recommended as a makeshift in view of the dearth of pig-iron.

TRADE WITH CANADA.—Mr. F. W. Field, His Majesty's Trade Commissioner in Toronto, who is at present at the Department of Overseas Trade, says: "There was never a better time for United Kingdom manufacturers to establish or strengthen their trade connections in Canada. A temporary lull now prevails in Canadian demands generally, but this is likely to be of brief duration. Canadian importers are anxious to place their orders in the United Kingdom, and they can pay cash for most of their requirements. They have been compelled during recent years to purchase large quantities of merchandise in foreign countries, but there is an earnest desire to transfer this trade, as far as possible, to the United Kingdom, and to other parts of the British Empire. It is a mistake for United Kingdom manufacturers to believe Canadian import trade is so largely in the hands of foreign countries, that British traders have little opportunity to extend business. Canada is probably a more difficult market than are certain others, but it offers considerable scope for the development of British trade. It is necessary, however, to approach the market in the manner best suited to local conditions, having in view its geographical position, its extended area, and the competition likely to be met. The Department of Overseas Trade is in a position to advise United Kingdom manufacturers on these matters."

THE SHIPBUILDING, ENGINEERING AND ELECTRICAL EXHIBITION AT GLASGOW.

(*Continued from page* 681.)

WE propose this week to refer in detail to some of the internal combustion engines which are on view at the Glasgow Exhibition. As indicated in an earlier article this class of exhibit is shown by a large number of firms, a fact which may be attributed not only to its growing importance and its application for many different purposes, but also to the fact that such engines form self-contained units well suited to exhibition display, which can in general be shown without difficulty in the space available. This applies, of course, more particularly to the small and medium-sized engines. Many of the small units are shown in motion, either under their own power or driven by electric motors, a feature which adds to the attraction of the exhibition at least from the point of view of the general public.

The largest exhibit, under the heading of internal combustion machinery, is a Diesel engine built by the North British Diesel Engine Works, Whiteinch, Glasgow. These works were commenced in 1913, and were in a condition to start work in November, 1914. They were designed and laid out especially for marine Diesel engine work. Since then, munitions of all types, marine machinery (steam, reciprocating and turbine) as well as a large number of Diesel engines have been produced.

The exhibit which we illustrate in Figs. 23 and 24, opposite, is a four-cycle 300 h.p. auxiliary Diesel set, coupled to a direct current dynamo by Messrs. W. H. Allen, Sons and Co., Limited, of Bedford, which is to be installed on board the motor ship Magvana, one of a number of passenger-carrying Diesel-driven vessels for the British India Steam Navigation Company, at present under construction. The main Diesel engines are designed and built by the same firm. This Diesel generator set is one of a number to be installed on each ship, and supplies current for driving the auxiliaries and winches, for electric lighting and other purposes. The only steam aboard these vessels will be supplied from a small steam donkey boiler for ship's heating, all the rest of the auxiliary machinery being electrically driven. We have previously remarked on the economies to be effected by this system of auxiliary driving. The sets of which we illustrate an example, are each of six cylinders, working on the four-stroke cycle principle, and develop their power of 300 brake horse-power at 375 r.p.m. The cylinders are 11¼ in. diameter, with 14½ in. stroke, so that even at the relatively high speed of revolution of 375 r.p.m., the piston speed is comparatively moderate.

Generally, the design follows standard practice for this class of Diesel generator. The engine is totally enclosed, and forced lubrication is adopted throughout, the solid forged crankshaft being suitably drilled to this end. The pumps for forced lubrication and water circulation are not directly driven from this engine, the supply being arranged from the engine-room auxiliaries. At the forward end of the engine, as will be seen, driven by an overhung crank, is the three-stage compressor for supplying the fuel injection air. It is of the well-known design of Messrs. Murray, Workman & Co., Limited, and was built and supplied by them. In general, it follows standard lines. The valves are all accessible as well as the intercoolers, from which, by removing the covers, the nests of tubes can readily be withdrawn. The main engine cylinders have separate liners and are bolted, as shown, to the crankcase. Each cylinder head contains the usual valves, inlet, fuel, exhaust and relief and in the case of the four central cylinders a starting air valve is also provided. In connection with the exhaust valve gear, levers will be seen which serve to relieve the cylinder compression for turning the engine, or on "stopping" to prevent reversal of current in the generator. The four starting cylinders have their starting air and fuel valves mounted eccentrically on the valve lever fulcrum shaft, so that when the engine has gained speed on starting air, rotation of these eccentric sleeves cuts out the starting air and puts the fuel

valves into operation. Adjacent to the lever controlling this operation is the master valve for starting air. The camshaft is driven by a vertical shaft through spiral gearing from the main crankshaft. The group of the six fuel pumps, one for each cylinder, will be seen between cylinder Nos. 5 and 6. These fuel pumps are divided into two sets of three each, driven by an eccentric, and are controlled on the suction valves in the usual way either by hand or by the governor.

A small hand pump is fitted for the initial fuel priming, and means are provided whereby the governor can be regulated by hand to enable higher or lower speeds and voltage to be attained. A commendable feature is the neat grouping of the five pressure gauges on the air, oil and water services. Forced lubrication for the main pistons is provided by a "Vacuum" type 12-feed lubricator, and a similar type with two feeds serves for the lubrication of the pistons of the injection air compressor. Indicator gear, driven from the main engine pistons, is provided and comes out through the crank chamber front doors. At the back of the engine the exhaust and induction pipes will be seen,

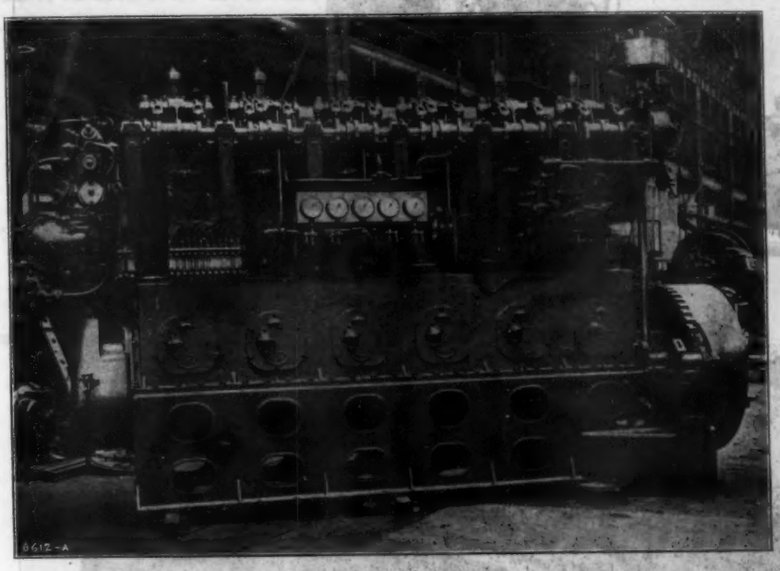


FIG. 23. 300-B.H.P. DIESEL ENGINE; THE NORTH BRITISH DIESEL ENGINE WORKS, LIMITED.

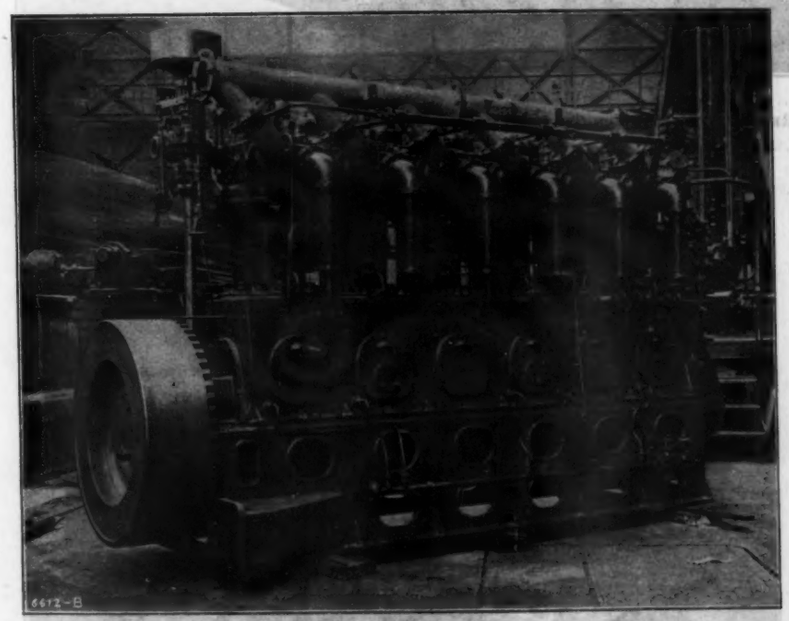


FIG. 24. 300-B.H.P. DIESEL ENGINE; THE NORTH BRITISH DIESEL ENGINE WORKS, LIMITED.

together with three connections between the induction pipes and the crankchamber, for removing excess of oil vapour, by drawing it into the main cylinders.

Prior to installation on board this engine was subjected to a continuous non-stop run in the makers' shops of seven days, in order to demonstrate the reliability and economy of the set. The results obtained were as follows:—The average fuel consumption for the seven days was 0·309 lb. per indicated horse-power hour of Anglo-Persian fuel oil of 0·39 density and 18,500 B.T.U. calorific value. The equivalent figure is 0·471 lb. per brake horse-power per hour, giving a ratio of brake horse-power to indicated horse-power of 0·66. The fuel injection air pressure was maintained at 1,000 lb. per square inch, and the delivery pressures from the stages of the compresser indicated efficient compression and an equal distribution of work throughout the stages.

This is the only example of the Diesel engine exhibited. The large number of semi-Diesels shows the striking advances that have been made with this type of oil engine within the last few years. Generally these engines are of small power—less than 100 brake horse-power total—for which the system is unquestionably suitable. The largest cylinder is of 50 brake horse-power, and the most powerful engine shown develops 200 brake horse-power in four working cylinders; it is illustrated in Fig. 26, on page 698. All these semi-Diesel engines, whether for land or marine purposes, follow the same general trend of design. In fact, so far as the general construction is concerned, standardisation to a large extent has set in. No example of the four-stroke cycle semi-Diesel engine is shown. All work on the two-cycle principle with exhaust and scavenging ports in the cylinders. In only one example, to be described in a future issue, is a separate cylinder under the main piston used for compressing the scavenging air, the system of crank-chamber compression being general. This scavenging makes forced lubrication impossible, so that the usual system of ring or drip for the main bearings and banjo feed for the bottom ends is standard. Development with this type of engine is taking place in the direction of eliminating the water drip into the scavenging air, which is still used in a number of engines to reduce the temperature resulting from combustion, and to prevent pre-ignition. Compression pressures are on the increase, and as a consequence the area of water-jacket cooled combustion chamber is a larger percentage of the total. For marine work the retention of the water-drip is decidedly an undesirable feature, since the requisite fresh water must be carried.

Most of the examples of semi-Diesel engines at Glasgow follow standard lines as shown in Figs. 25 and 26. The chief individual features of difference concern the arrangements for fuel feeding to the injectors in the main cylinder, the governing of the speed of revolution of the engine by controlling the fuel feed, and in the case of marine engines, the principle and the mechanism for carrying out reversal of direction of running. Reverse gears in which a clutch is incorporated are provided with many types of engines, although a greater tendency to provide a direct method of reversal is apparent.

The largest engine of this type is the four-cylinder 200 brake horse-power engine illustrated in Fig. 26, exhibited by Messrs. William Beardmore & Co., Limited, and built at their Coatbridge factory. The outstanding feature with this engine is the method of reversal, which follows marine Diesel practice. The engine is coupled direct to the propeller, no clutch or separate reverse gear being required. When it is desired to start ahead or astern, the handwheel at the forward end is turned either in an ahead or astern direction, operating air-control valves, setting an air distributer in action, and admitting air to the starting valves in the cylinders in the desired sequence. When speed is gained fuel ignition commences, and the air is cut out by a central push in the handwheel. Air at sufficient pressure is stored in separate reservoirs charged by an auxiliary compressor. Fuel is fed through a combined filter and meter attached to the exhaust pipe, to the four fuel pumps driven from two eccentrics on the crankshaft. Two horizontal plunger pumps, one for circulating the cooling water and the other for bilge duties aboard ship, are also driven from the forward end of the shaft. Governing is effected on the hit-and-miss principle. Speed control is accomplished by reducing, through the medium of a hand lever, the effective stroke of the fuel pumps, the governor only being required to act in an emergency, such as a shaft breakage, to prevent an undue increase in speed of revolution.

MARINE OIL ENGINES AT THE GLASGOW EXHIBITION.

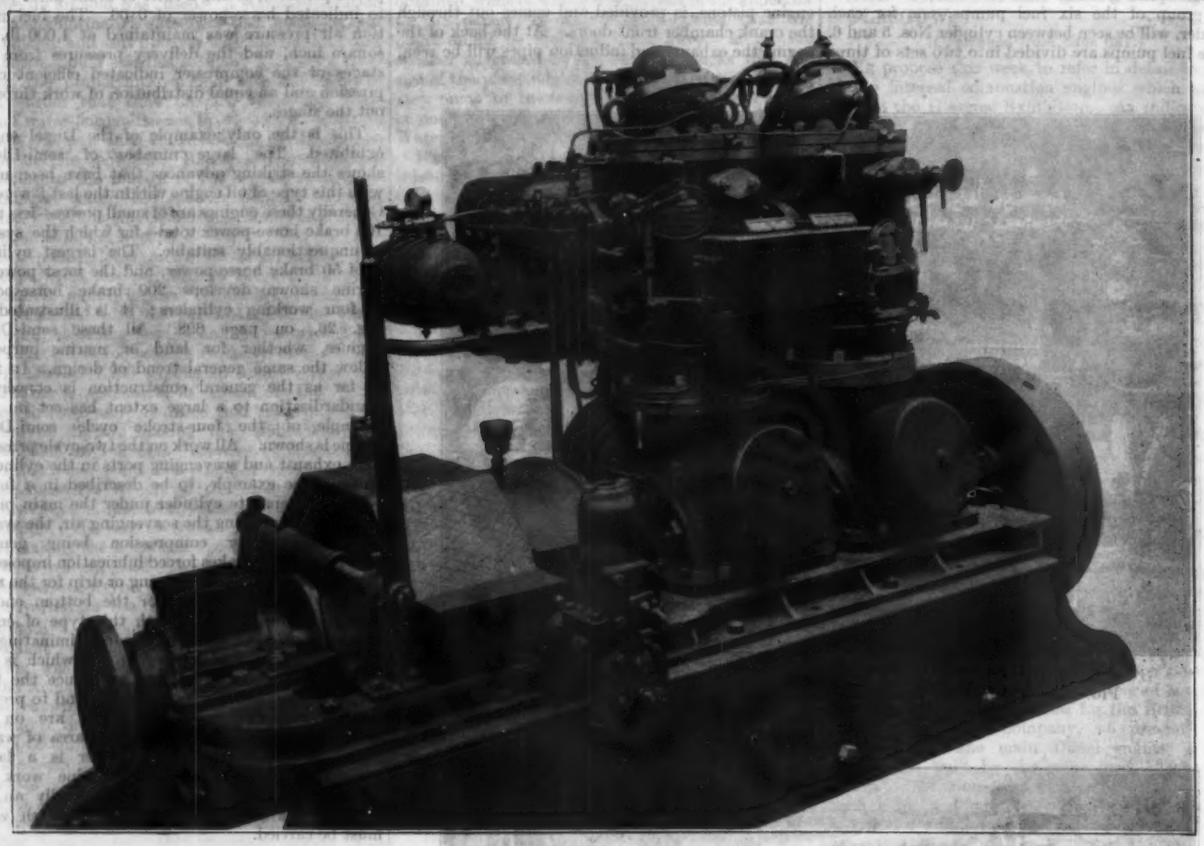


Fig. 25. 40-B.H.P. Direct-Reversing Marine Oil Engine; Messrs. Vickers-Petters, Limited.

The largest engine of this type constructed by Messrs. Beardmore has cylinders developing 80 brake horse-power each, and in six-cylinder units the total horse-power is 480 brake horse-power.

The Vickers-Petter oil engine exhibits may next be dealt with. These comprise a two-cylinder direct reversible marine set, developing 40 brake horse-power at 375 r.p.m., with a cylinder diameter of 9½ in. and a stroke of 10½ in. This set—engine and clutch—is illustrated in Fig. 25. A marine single-cylinder oil engine driven compressor is also exhibited. The engine has a cylinder of 8½ in. diameter with 9 in. stroke, and develops 13½ brake horse-power at 400 r.p.m. The compressor is of the well-known Reavell two-stage type, compressing to 1,000 lb. per square inch, and serves on Diesel-driven ships to charge up the reservoirs for starting and fuel injection air. The reversible two-cylinder marine set is probably the more interesting. In regard to the main features standard practice is followed. There is no water drip. The blow lamps for the initial heating of the bulbs are not separate units as is the common practice, but are an integral part of the engine, and are supplied, under pressure, with paraffin from a common reservoir, shown attached to the exhaust pipe.

For the initial start the engine is de-clutched, and after heating with the blow lamps, when the special plug in the hot bulb is sufficiently hot for combustion to be ensured, the engine is barred round into position, and a start made by admission of air through the hand-operated valve in the forward cylinder. One or two impulses on air put the engine into motion, and it then picks up on fuel. Although it is possible to reverse directly from full speed ahead to full speed astern and *vice versa* without de-clutching, it is generally expedient to de-clutch. Reversal is effected by an arranged pre-injection of fuel. After de-clutching the reversing lever is pulled in the required direction, throwing the fuel pumps out of action; when the speed has been reduced to a pre-determined point, a vigorous pre-injection takes place and drives the up-coming piston in the opposite direction. The gear for controlling these operations is extremely neat, and provided the tension of the springs governing the speed at which fuel pre-injection takes

Fig. 26. 200-B.H.P. Marine Oil Engine; Messrs. William Beardmore and Co., Limited.

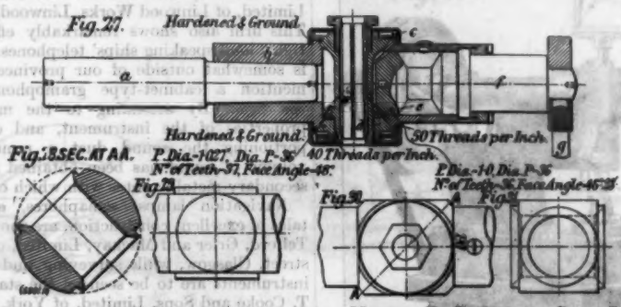
place, are maintained in adjustment, it is quite sure and certain.

The single-cylinder engine driving the compressor possesses the now well-known Vickers-Petter features to ensure slow running without danger of stopping due to the hot bulbs becoming too cold to support combustion, and without the blow lamp being required. This result is achieved by means of arranging at low and no loads, for a supplementary injection of fuel in advance of the main injection; this early combustion serving to maintain a sufficient temperature of bulb to ensure ignition of the main charge of fuel.

Again, for quick starting from cold, the special blow lamp and plug enable a start to be made within the minute. Alternatively electric heating may be adopted, a neat heater of this type having passed the experimental stage, and being fitted if desired. For initial starting, reservoirs are charged by a proportion of the combustion gas of one or more cylinders which is tapped off through a non-return valve incorporated with the starting air valve.

For house lighting, farm work, as a portable set, and so forth, a small two-cycle engine, known as the Petter Junior is being made as a single-cylinder unit in three sizes: 2½ brake horse-power, 5 brake horse-power and 8 brake horse-power. The 8 brake horse-power engine is shown coupled to a Reid winch; one 5 brake horse-power engine is coupled to a direct current generator, and another which is exhibited with a belt pulley on the extension of the crankshaft, is suitable for farmer's work. A small 2½ brake horse-power engine is also shown. These engines start on petrol and are changed over on to paraffin when hot. The engine being of the two-stroke type with crank-chamber compression, are of the very simplest valveless construction, with magneto ignition.

Leaving other internal combustion engines until next week, we may conclude this article by dealing with some of the interesting machines and appliances which are to be found among the more miscellaneous exhibits at Glasgow. We may first refer to a novel grinding attachment for use in connection with the manufacture of plain internal gauges which is illustrated in Figs. 27 to 31, on this page. This class of gauge is usually known as a point gauge, and this name precisely indicates a usual defect of this form of appliance which it is the purpose of the grinding attachment to eliminate. Such gauges are quite frequently made with cone ends terminating in a more or less rounded point. The objections to this construction are that as the ends bear only on points they wear rapidly, and also that the gauge registers correctly only when it is exactly at right angles to the axis of the work being tested, and truly on the plane of cross-section. The purpose of the grinding attachment is to produce gauges of this class with the ends formed at the same radius as that of the hole being tested. With such a form the gauge has a considerable bearing surface on the work, so that its life is prolonged, and at the same time it registers accurately over a considerable working range. As will be clear, the angle of this range is determined by the diameter of the stock from which the gauge is made.



FIGS. 27 TO 31. GAUGE GRINDING ATTACHMENT; MESSRS. T. COOKE AND SONS, LTD., YORK.

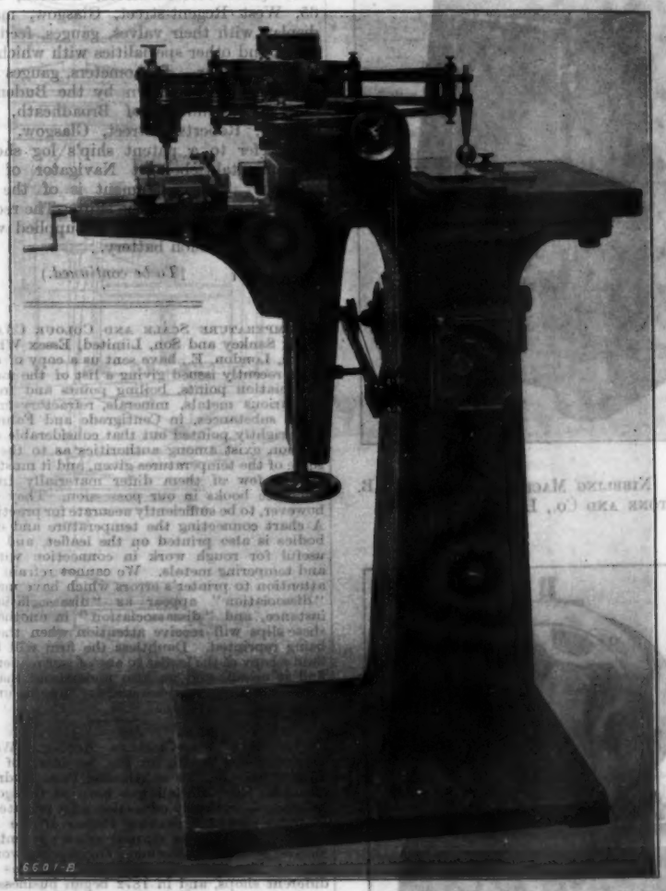


FIG. 32. ENGRAVING AND PROFILING MACHINE; MESSRS. T. COOKE AND SONS, LTD., YORK.

This grinding attachment, which is manufactured by Messrs. T. Cooke & Sons, Limited, of Buckingham Works, York, is suitable for use in almost any grinding machine or lathe. It is clearly shown in detail in Figs. 27 to 31, and from these it will be seen that it consists of an arbor, *a*, shown at the left-hand side in Fig. 27, which is carried on the spindle nose of the grinding machine or lathe. The outer end of the arbor may be tapered to suit the machine on which the appliance is used. This arbor is attached to, and carries a centre sleeve, *b*, which is formed with a central hole at right angles to the axis of the arbor and sleeve. This central hole carries a second sleeve, *c*, which has a cone bearing on the main sleeve at one end and at the other is arranged to take a circular nut, *d*, which sets against a second cone bearing on the main sleeve. The right-angle sleeve can rotate in the main sleeve, and the nut, *d*, is formed with bevel teeth at *e*. These gear into teeth formed in the spindle, *f*, which fits into the free end of the main sleeve, *b*.

When using the attachment the arbor, *a*, is fixed in the nose of the grinder or lathe, and is rotated by the machine. The spindle, *f*, is, however, prevented from rotating by the projecting rod, *g*, which is arranged to come against an obstruction such as the tail-stock, or bed. The result of this arrangement is that the centre sleeve, *c*, rotates as a whole with the main sleeve, *b*, and at the same time rotates on its own axis as it is driven by the bevel pinion. The gauge to be ground is carried by the sleeve, *c*, which is provided with a clamping arrangement, as shown in Fig. 27, and it will be clear that when the appliance, carrying a gauge, is mounted on a grinding machine in the way described, and the ends of the gauge are brought up against the grinding wheel, that these ends will be finished with spherical ends of a radius equal to half the length of the gauge, so that the form to which we referred earlier is produced. The appliance is constructed to take ⅜ in. rod, which is a convenient size for ordinary inside point gauges, and is capable of grinding gauges down to a minimum length of 2½ in. The maximum length which can be dealt with depends naturally either on the height of the centres of the machine on which the grinding is being carried out, or in the limit on the amount of spring in the gauge itself.

Another interesting exhibit which is shown by Messrs. T. Cooke & Sons, Limited, takes the form of an engraving and profiling machine, is illustrated in Fig. 32, annexed. The general lines of this machine will be clear from the figure. It consists of a pantograph copying arrangement, the form being copied being carried on a fixed table above the main pillar of the machine, and the article being produced being carried on a table which has considerable vertical adjustment. This allows the machine to be used for direct engraving, or for profiling work, on large objects, and it is not restricted in any way to the manufacture of name-plates. The table carrying the work has both cross and side adjustment, as will be clear from the figure. The engraving tool drive will also be followed from Fig. 32. It comes from a small motor fixed on the pillar of the machine. This

motor is behind the pillar in the figure, but the end of it can be seen, as also the driving pulley. The driving gut is carried round a series of pulleys in order to carry it to the tool spindle, and at the same time maintain the necessary flexibility of movement of the pantograph. A double-jockey pulley on the end of a hanging lever maintains the tension.

The maximum surface covered by the cutter end of the pantograph is roughly 14 in. by 9 in., and the cutter spindle has a vertical feed movement of ½ in. An adjustable stop is provided to ensure uniform depth of cut. The two main arms of the pantograph are fitted with scales and arranged so that the machine may be adjusted for engraving letters of any size from 2 in. (the full size of the copy) down to one-quarter full size, or ½ in. For smaller letters a smaller copy must be used and letters down to $\frac{1}{32}$ in. may be easily and neatly cut. A circular revolving and tilting table is supplied with the machine, and enables bevelled work to be handled without any difficulty. Where no great degree of precision is required the circular table enables simple dividing to be carried out. In addition to the engraving of letters and similar work, the machine has proved very useful for producing small irregularly-shaped articles from copies in cases in which the quantity required did not justify the making of dies for punching, or in other cases where a mechanical finish was required.

Another interesting machine tool of small type, which is to be seen at the exhibition, is illustrated in Fig. 33, annexed. This also, like the engraving machine, is suitable and intended for the manufacture of irregular parts. The operation of the machine is confined to the cutting of sheet metal, however, but in its own sphere it should be of considerable value. The tool, which is called by the makers a "nibbling machine," and is exhibited by Messrs. J. B. Stone & Co., Limited, of 135, Finsbury-pavement, London, E.C. 2, is of very simple type. It consists of an arm carrying a rapidly reciprocating punch of small size, which works above a female die carried by the bed-plate. The method of drive will be clear from our illustration. A vertical adjustment for the punch is provided in order to accommodate different gauges of metal. The machine is made in two sizes, the smaller with a 6 in. gap, being capable of dealing with metal up to ¼ in. thick, and the larger, with 12 in. gap, dealing with metal up to ½ in. thick. The method of operation is simply to guide the sheet by hand under the punch when the various holes produced running each into the next results in a slot being formed. A template may be used, and the machine cuts a clean edge which, in the majority of cases, would require no dressing after leaving the machine. The material may be cut up to a rate of 18 in. a minute, and very complicated shapes may be produced without difficulty. The machine should be of much value for many classes of work which normally demand either expensive hand-work, or expensive dies.

Our final illustration this week shows a type of rotary pump which appears to be meeting with considerable success. It is manufactured by Messrs. Feuerheerd's Rotors (British Empire), Limited, of 31, New Bridge-street, E.C. 4, and 105, West George-street, Glasgow. This pump was, we believe, introduced some year or two ago and has been adopted for various services. Rotary pumps, generally with two rotors working around different centres, have, of course, been devised in an almost endless number of forms, and many of them, particularly those of the gear type, have taken a definite place in engineering work. The particular claims which are made for the Feuerheerd construction are that a large output per revolution for the size of the pump is obtained and that the single inner rotor carried on the shaft meshing with a floating outer rotor results in a minimum of friction and wear.

The action of the pump will almost be obvious from Fig. 34, but it may be said that the inner rotor only is driven and that the outer is propelled by the projections of the inner rotor meshing with its pockets. It will be clear that line contact is maintained between the two moving parts, but where the top of the projection passes over the hole between the pockets it is claimed that there is neither friction nor wear since no pressure is exerted between the surfaces at this part of the cycle. The actual drive takes place through the pockets in which the inner rotor rolls on the outer. As will be obvious, the pumps are uniform across a vertical cross-section, and consequently are reversible. The standard pump is designed to deliver up to a total

Fig. 33. Nibbling Machine; Messrs. J. B. Stone and Co., Ltd., London.

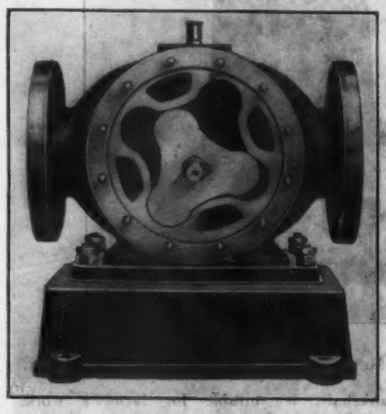


Fig. 34. Feuerheerd's Rotary Pump.

head of 200 ft., but it is stated that higher lifts can be attained. As an example of capacity we may quote the 2½ in. pump. This runs at 500 r.p.m., and delivers 2,700 gallons per hour. By speeding the pump up to 720 r.p.m. an output of 3,850 gallons an hour is obtained. The 1-in. pump, running at 1,200 r.p.m., delivers 400 gallons an hour.

We may finally, this week, refer to one or two of the stands which are devoted to scientific apparatus or instruments. One of the more prominent of these is that occupied by Messrs. Kelvin, Bottomley and Baird, Limited, of 18 Cambridge-street, Glasgow. This firm shows examples of their well-known magnetic compasses, sounding machines, &c. Important exhibits are the Denny-Edgecombe torsionmeter and the pneumercator draught indicator, both of which have been dealt with in our columns in the past. Compasses and binnacles are also shown by Messrs. Dent and Co. and Johnson, Limited, of Linwood Works, Linwood, near Paisley. This firm also shows remarkably effective watertight, loud-speaking ships' telephones. Although it is somewhat outside of our province we may also mention a cabinet-type gramophone shown by the firm. By attending to the minor acoustic properties of the instrument, and correctly proportioning the sound duct, a remarkably clear volume of sound has been obtained free from the secondary metallic notes with which one is familiar.

Navigation lamps, semaphores, electrical tell-tales of excellent construction, are shown by Messrs. Telford, Grier and Mackay, Limited, of 10, Carrick-street, Glasgow, while surveying and astronomical instruments are to be seen on the stand of Messrs. T. Cooke and Sons, Limited, of York. The Crosby Valve and Engineering Company, Limited, of 147, Queen-Victoria-street, London, E.C. 4, and 65, West Regent-street, Glasgow, make a good display with their valves, gauges, feed-water regulators and other specialities with which our readers will be familiar. Tachometers, gauges and thermometers are also shown by the Budenberg Gauge Company, Limited, of Broadheath, Manchester, and 62, Robertson-street, Glasgow. Finally, we may refer to a patent ship's log shown by the Instrumentaktiebolaget Navigator of Stockholm, Sweden. This instrument is of the Pitot tube type and is built into the ship. The record is made on an electrical instrument supplied with current from a low-tension battery.

(To be continued.)

Temperature Scale and Colour Chart.—Messrs. J. H. Sankey and Son, Limited, Essex Wharf, Canning Town, London, E., have sent us a copy of a leaflet they have recently issued giving a list of the melting points, dissociation points, boiling points and freezing points of various metals, minerals, refractory materials and other substances, in Centigrade and Fahrenheit units. It is rightly pointed out that considerable differences of opinion exist among authorities as to the accuracy of some of the temperatures given, and it must be admitted that a few of them differ materially from those in reference books in our possession. They are thought, however, to be sufficiently accurate for practical purposes. A chart connecting the temperature and colour of hot bodies is also printed on the leaflet, and this may be useful for rough work in connection with hardening and tempering metals. We cannot refrain from calling attention to printer's errors which have made the word "dissociation" appear as "disassociation," in one instance, and "dissassociation" in another, and hope these slips will receive attention when the leaflets are being reprinted. Doubtless the firm will be willing to send a copy of the leaflet to any of our readers who would find it useful, and we also understand that they have some copies mounted on card for hanging on the wall.

The late Mr. Charles McNeil.—We regret to announce the death, on the 1st inst., of Mr. Charles McNeil, the founder of Kinning Park Hydraulic Forge, Glasgow. Mr. McNeil was born at Glasgow in 1847; he received his early education at a private school, and later he attended evening classes at the Andersonian College. In 1863 he started as an apprentice smith in Messrs. P. and W. McOnie's engineering works. At the end of his apprenticeship he worked as a smith in different shops, and in 1872 began business for himself on a small scale at Morrison-street, Glasgow. Two years later he purchased ground on the site of the existing works, at 270, West Scotland-street, Glasgow, and erected buildings there to meet the requirements of his business. He devised shortly after, and patented in 1876, the corrugated manhole door, the success of which led him to put down a number of heavy hydraulic presses to meet the growing demand. In 1891 further large extensions had to be made in his premises, when he introduced pressed steel ladles for foundries, weldless steel standpipes for boilers and other specialities. During the war his works greatly aided in supplying the nation's needs. The Star Foundry was purchased in 1916, and a large new forge was rapidly erected on its site. There also he installed several heavy drop hammers and more recently a large steam intensifier hydraulic press, capable of handling forgings up to 50 tons weight. In 1880 he became a member of the Incorporation of Hammermen, and was elected a member of the Iron and Steel Institute in 1891. Mr. McNeil was a thoroughly straightforward business man and a genial friend.

THE ROTARY UNIT LIGHT CAR.

CONSTRUCTED BY MESSRS. ROTARY UNITS, LIMITED, ENGINEERS, WOOBURN GREEN.

Fig. 1.

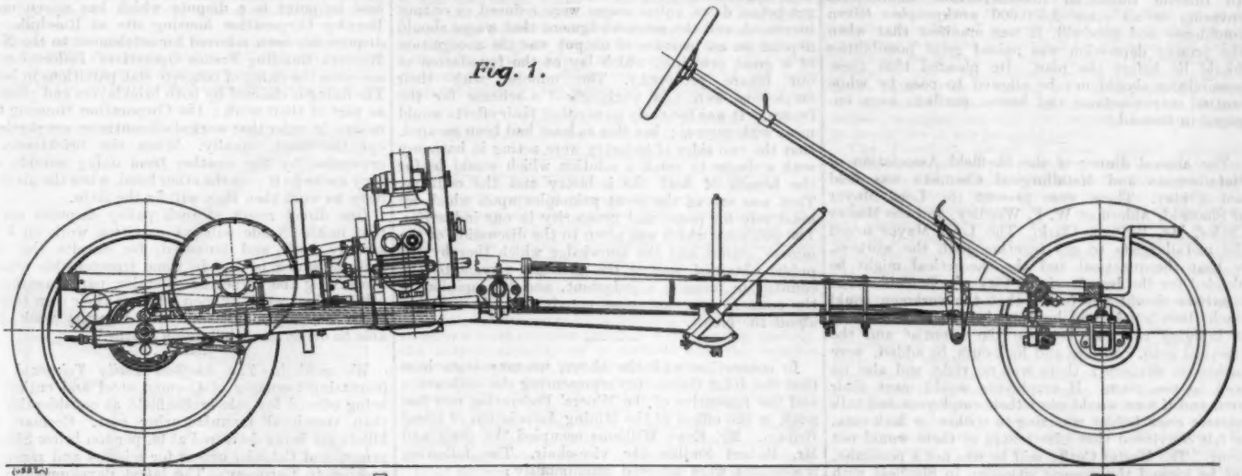


Fig. 2.

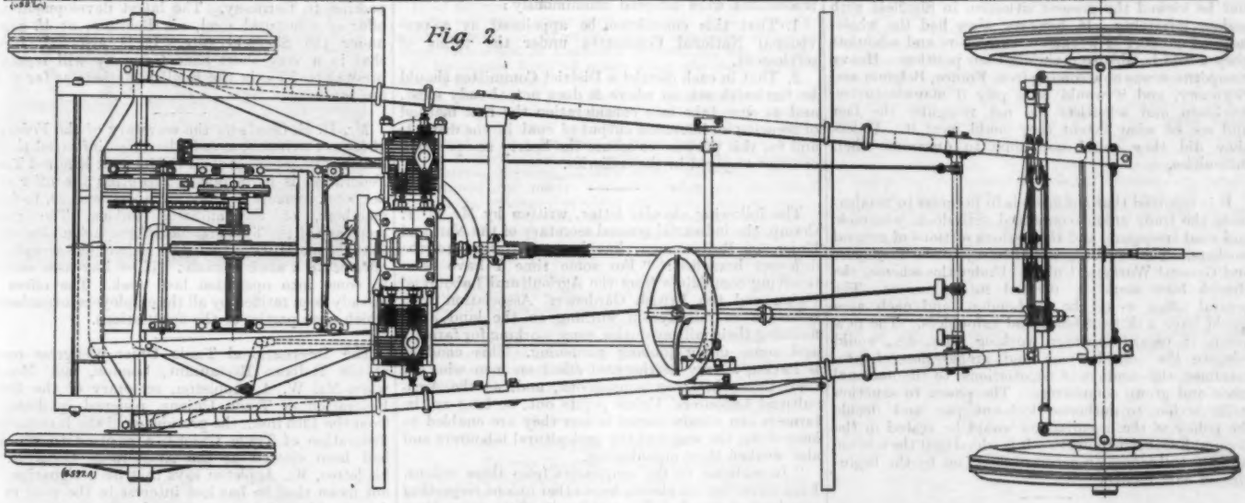


Fig. 3.

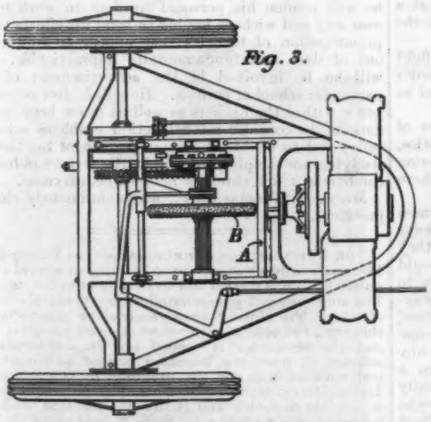
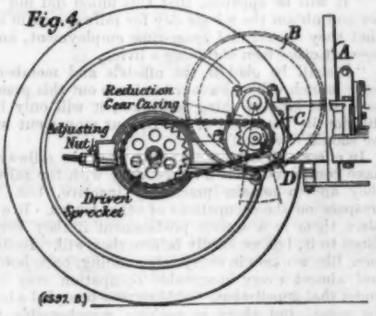


Fig. 4.



In the lighter and cheaper class of cars designed to meet a demand for something smaller and cheaper than the usual type was one shown at the recent Motor Show by Messrs. Rotary Units, Limited, Wooburn Green, Bucks. This we illustrate above.

This car is of the friction-driven type, with horizontally-opposed air-cooled engine. The main feature is that the engine, back axle, and all the transmission gear are carried on a subframe and are really built up as one unit. This unit is pivoted on a cross member of the frame at the front and attached by the springs at the rear. No universal joints are therefore required, nor is there any relative motion of the sprocket wheels of the chain; the latter can therefore be short. The general arrangement of the chassis is shown in Figs. 1 and 2, while a diagrammatic plan of the unit is shown in Fig. 3 and an elevation of the transmission in Fig. 4.

Mounted on the engine shaft is a flat-faced wheel A, which is pressed into contact with the friction wheel B. The latter slides along its shaft under the control of the change-speed lever, being in neutral in the position shown. The various forward speeds are obtained by sliding it to the right; the reverse by sliding it to the left. A pair of enclosed spur wheels C reduce the speed to the sprocket wheel D which drives the back axle by chain. By employing this reduction gear a moderate reduction in the chain is made possible, which is a great advantage to the chain. The axle is solid and has no differential, and both brake drums are fixed to it. The cylinders are 85 mm. by 88 mm. (approximately 3⅜ in. by 3 7/16 in.), and are made of steel with detachable cast-iron heads. Both main and big-end bearings are of the roller type. The frame is of ash reinforced by steel plates, and all springs are quarter-elliptical. Steering is effected by a wire rope coiled round a drum at the bottom of the steering column, the two ends of which are attached to a bracket sliding on a bar which is connected to the steering arm on the axle.

The wheel base is 8 ft. 6 in. and track 3 ft. 6 in. The weight is 8 cwt., and in consequence of the low weight 28 in. by 3-in. tyres can be used. The whole is an interesting example of a type of vehicle which aims at being a really light two-seater and not at competing with the small car weighing some 13 cwt. or more.

INDUSTRIAL NOTES.

Speaking at Loughborough Technical College last Friday, Dr. Macnamara, Minister of Labour, stated that the success of industrial undertakings depended, like everything else, upon the relationship subsisting between the contributory parties. There were, unhappily, mischievously-minded people about who insisted that the interests of the employer and the employed could never be other than antagonistic. The application of the spirit of Whitleyism in industry and the manifest success which had so far attended that application was slowly but surely establishing the contrary, and with the happiest results. Under the Whitley Council plan, employers and employed got together; learn, perhaps, for the first time, each other's point of view; and realise, perhaps, for the

first time, that each is not, of a necessity, the born enemy of the other. There were now in active operation 63 Joint Industrial Councils, with District Associated Councils and Committees, together with 16 Interim Industrial Reconstruction Committees covering in all some 3,500,000 workpeople. Given confidence and goodwill, it was manifest that when the present depression was passed great possibilities would lie before the plan. He pleaded that these possibilities should not be allowed to pass by while mutual recriminations and barren conflicts were engaged in instead.

The annual dinner of the Sheffield Association of Metallurgists and Metallurgical Chemists was held last Friday. There were present the Lord Mayor of Sheffield, Alderman W. F. Wardley, and the Master Cutler, Mr. William Clark. The Lord Mayor urged the metallurgists to get together with the workers, so that the practical and the theoretical might be blended for the benefit of the City of Sheffield. The scientists should not forget that the workmen could teach them much, and he appealed to them to help in bridging the gulf between the scientist and the practical man. Strikes and lock-outs, he added, were barbarous weapons; there was no right and also no need to use them. If employers would meet their men, and if men would meet their employers and talk matters over before resorting to strikes or lock-outs, he felt convinced that nine-tenths of them would not occur. The Master Cutler said he was not a pessimist, but he viewed the present situation in Sheffield with serious misgiving. If, however, they had the whole-hearted support of workmen, employers and scientists they would be able to maintain their position. Heavy competition was now coming from France, Belgium and Germany, and it would be a pity if manufacturers, workmen and scientists did not recognise the fact and see to what extent they could meet it. Unless they did they could not hope to overcome their difficulties.

It is reported that a scheme is in progress to amalgamate the trade unions connected with dock, waterside and road transport, and the various sections of general workers. The new body would be styled the Transport and General Workers' Union. Under the scheme, the British Isles would be divided into 11 areas. The central office would be in London, and each area would have a district office and sub-offices. The new union, in regard to wages, working rules, &c., would relegate the consideration and preparation of programmes, the conduct of negotiations, to the national trade and group committees. The power to sanction strike action, to authorise lock-out pay and decide the policy of the organisation would be vested in the General Executive Council. It is added that the scheme is likely to become an accomplished fact by the beginning of next month.

The report for November of the United Society of Boiler Makers and Iron and Steel Shipbuilders stated that "the Society's wages claim for an advance of 6*d*. per hour still hangs in the balance; this claim is a common one to all trades in the shipbuilding and engineering industry. The 'Yea' or 'Nay' of the employers is to be given about the middle of November, so as to allow the members of each society to consider it before the first day of December, the day on which the men asked that the advance should begin. They also asked for the consolidation of war wages and percentages into a unified hourly or weekly rate." Negotiations in the matter have been proceeding of late, and a joint conference was held last Friday between the Shipbuilding Employers' Federation, the Federation of Engineering and Shipbuilding Trades Unions and the National Federation of General Workers. At the close, the following statement was issued: "The whole subject of the application for a general advance in wages and the consolidation of war wages was discussed and certain representations made by the leaders of the trades unions were considered by the employers. At the suggestion of the employers the conference was adjourned till a day to be fixed early in December. The Joint Sub-Committee which had been appointed to deal with the question of consolidation of war wages is proceeding with its work." One of the men's delegates stated that in the event of the employers refusing the men's claim a court of public inquiry into it would be pressed for.

Sir Robert Horne, President of the Board of Trade, speaking last Friday at the dinner of the Parliamentary Press Gallery, and referring to the recent coal strike, said that an effect it certainly had was a recoil from the theory of direct action on the part of the largest and most powerful trade union in the country. Direct action was the most subversive principle that could be applied in conducting the affairs of any country. His firm belief was that the heart of the nation was sound and our people could be relied upon to resist direct action. A second point was that an acknowledgment had been obtained from that great industry that wages should depend on results. One could not get prices down unless wages were reduced or output increased, and the acknowledgment that wages should depend on an increase of output was the recognition of a great principle, which lay at the foundation of our future prosperity. The miners, with their employers, were now working out a scheme for the future. It was too early to say that their efforts would meet with success; but this at least had been secured, that the two sides of industry were acting in harmony with a desire to reach a solution which would be for the benefit of both the industry and the country. That was one of the great principles upon which we must rely for peace and prosperity in our industries. The publicity which was given to the discussion of the miners' claims and the knowledge which thereby the public obtained was of the greatest service to the country in forming a judgment, and the opinion of the country operated most convincingly in bringing about the result.

In connection with the above, we may state here that the Joint Committee representing the coalowners and the Executive of the Miners' Federation met last week at the offices of the Mining Association of Great Britain. Mr. Evan Williams occupied the chair and Mr. Robert Smillie the vice-chair. The following resolutions were adopted unanimously:—

1. That this committee be appointed as a provisional National Committee under the terms of settlement.

2. That in each district a District Committee should be forthwith set up where it does not already exist, and at once take into consideration the best method of securing an increased output of coal in the district, and for this purpose to secure the hearty co-operation of those engaged in the collieries.

The following circular letter, written by Mr. C. T. Cramp, the industrial general secretary of the National Union of Railwaymen, has been addressed to the different branches: "For some time I have been receiving complaints from the Agricultural Labourers' Union and the British Gardeners' Association with reference to railwaymen working on the land after finishing their railway duties, some working for farmers and some doing jobbing gardening. This conduct is having a very detrimental effect on men who get their living in those occupations, and, as the Agricultural Labourers' Union points out, so long as the farmers can obtain casual labour they are enabled to keep down the wages of the agricultural labourers and also weaken their organisation.

"In addition to the complaints from these unions, I am receiving complaints from other unions respecting members of the N.U.R. working in their spare time as musicians, painters, &c., and the result is that a very bad feeling exists in some districts against the N.U.R. and its members.

"It will be apparent that this union did not fight for and obtain the 8-hour day for railwaymen in order that they should find spare-time employment, and so prevent other men obtaining a living.

"I shall be glad if the officials and members of your branch will endeavour to stamp out this practice, as if this kind of thing continues, it will only bring division in the ranks of the Labour movement where we should have unity."

In effect, this letter means that when the railwaymen have completed their 8 hours' duty with the railways they are to remain practically inactive, lest they trespass on the occupations of other trades. It would place them in a serious predicament if they were to listen to it, but we hardly believe they will. Railwaymen, like workers in every other calling, have hobbies, and almost every imaginable occupation may come under that appellation. Cobbling may be styled a hobby for some, and there is nothing reprehensible in a railwayman mending his own boots, those of his family and why not then those of his neighbours if he likes to do so and finds it a help to his household. Many have a bent for gardening and own an allotment which supplies them with the garden produce they need—a sin in itself against greengrocers according to this circular—and why they should not help third parties in the same capacity if they like to do so is difficult to understand. The circular would even prevent the railwaymen from cultivating the fine arts to their own profit and for the benefit of others. There have been railwaymen poets before now. A railwayman cannot act the railwayman at home; he is, further, only too glad to forget his daily drudgery—and we all have a large amount of that—in a change of work which means a rest, and if the following of his quite reasonable inclination yields him both satisfaction and profit he should be permitted to follow it by all means, in this "a free country"?

The apportionment of work among various trade unions is fast becoming a most intricate problem. A case in point is a dispute which has arisen on the Burnley Corporation housing site at Rosehill. The dispute has been referred for settlement to the North-Western Building Trades Operatives' Federation, and concerns the fixing of concrete slab partitions in houses. The fixing is claimed by both bricklayers and plasterers as part of their work; the Corporation Housing Committee, in order that work shall continue, are portioning out the work equally. When the bricklayers are prevented by the weather from doing outside work they are to do it; on the other hand, when the plasterers have no work then they will fix the slabs.

One direct result of such paltry disputes may be that neither trade will get partition work on houses already built and tenanted, for despite the cheap ridicule which is cast in some irresponsible quarters concerning the carpeting of stairs, paperhanging and other indoor work by men who are their own tenants, there are very many handymen in every walk of life able to dispense with "union labour."

We read in *The Sheffield Daily Telegraph* that increasing tonnages of German steel and cutlery are being offered for sale in Sheffield at considerably less than the local manufacturing cost. German steel billets are being delivered at 9*l*. per ton below Sheffield prices, and Colonial orders for scissors and razors are passing to Germany. The latest development is an offer of structural steel, *via* Belgium, at 4*l*. per ton under the Sheffield rate. It is asserted, further, that in a very short time Germany will regain her pre-war position in the English markets as far as toys are concerned.

Mr. H. E. Goodwin, the secretary of the Federation of Master Printers, says he has been informed that the ballot of members of the Printing and Kindred Trades' Federation is in favour of accepting the offer of 5*s*. per week increase to male members, and 2*s*. to female members, of the affiliated unions. The general secretary of the Typographical Association also reports that the members of that association have accepted the offer of 5*s*. a week increase. These increases were due to come into operation last week. The offers had already been ratified by all the employers' organisations which were parties to the negotiations.

The International Trade Union Congress opened at the Holborn Restaurant, London, last Monday, when Mr. W. A. Appleton, secretary of the British Federation of Trade Unions, resigned by letter, as from the 13th inst., the presidency of the International Federation of Trade Unions, a position to which he had been elected at the Amsterdam Congress. In his letter, Mr. Appleton says that his resignation does not mean that he has lost interest in the poor or the downtrodden of any country, but it does mean that he will resume his personal freedom to work in his own way and without having to bend his efforts to the promulgation of theories that appear to him to be out of date and fundamentally impracticable. Nor will he be involved in the advertisement of any particular school of politics. He will be free to preach peace within the nations as well as peace between the nations, to consider reconstruction problems scientifically, and to devote a greater portion of his time to studying and helping to combat the serious industrial conditions which threaten his own countrymen.

Mr. J. H. Thomas, M.P., was unanimously elected president.

THE UNIVERSITY OF BIRMINGHAM.—The University of Birmingham has recently issued an urgent appeal to the public for funds needed to carry on and extend its work. The sum required is estimated at 500,000*l*., about half of which has already been received or promised. Of this sum, 130,000*l*. is required to clear off a capital debt, and the remainder is needed for the adjustment of salaries, to meet the increased cost of administration and maintenance, for the provision of new accommodation for existing departments, for the establishment of new departments and chairs for research work and for many other purposes. Since it is obvious that the other provincial universities cannot meet the requirements of the seven Midland counties, the youth of the latter will be at a serious disadvantage, as compared with that of other large prominent areas, if the work of the University of Birmingham has to be curtailed. This, we understand, must inevitably follow unless a large addition can be made to the annual income of the university, but we have little doubt that, when this is fully realised by the citizens of Birmingham and by the inhabitants of the Midland counties generally, their response will be sufficient to remove all cause for anxiety on the part of those responsible for carrying on the work. The office of the appeal fund is at 95, Colmore-row, Birmingham, and from this address a booklet briefly and clearly explaining the university's need, may be obtained.

WATT'S EARLY PUMPING ENGINES.

To the Editor of Engineering.

Sir,—Among Watt's numerous examples of early contrivances collected for the Watt Centenary celebrations few are of more interest than that of the pumping engine belonging to the old dry dock at the West Harbour, Greenock.

As far as can be ascertained this engine must have been in use for fully 135 years, and is still in good working order. It is shown in the accompanying Figs. 1 and 2.

Owing to the development of business enterprise at the

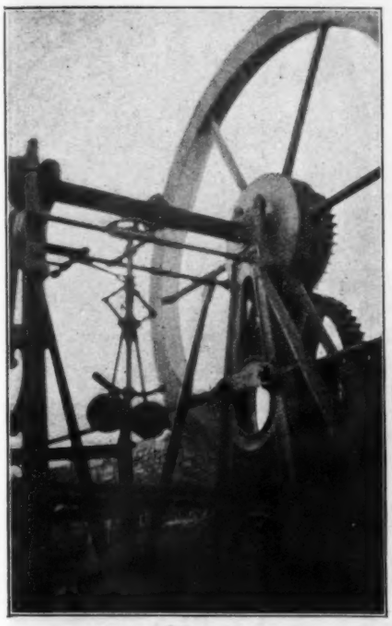


Fig. 1.

Fig. 2.

port and the closing up of the harbour this memorable early type of steam engine will be removed to the Watt Museum at Greenock.

The graving dock, which measures about 220 ft. by 50 ft., having a depth of about 10 ft. on the sill, was constructed by James Watt in 1785, so that taking this date, the engine is about eleven years after Watt's Smethwick pumping engine at the canal near Birmingham, which has already been alluded to in your issue of August 29 last year.

As a civil engineer Watt designed the first graving dock in Scotland, which is at Port Glasgow, in the year 1762. This dock is still in use.

The photograph, Fig. 1, shows the admirable contrivance of Watt, namely, the "Governing balls," which remains to the present day without any material alteration even in the best steam engines—the throttle valve for regulating the rate of admission of steam, and the centrifugal governor, a double conical pendulum which controls the speed by acting on the throttle valve and shows the balls hung on the ends of the pivoted arms. The other photograph, Fig. 2, shows the outer end of the main shaft connected to the pump rod for emptying the dock.

Yours faithfully,

John W. Grant, A.M.C.Inst.(Lond.).

10, Kelly-street, Greenock, November 22, 1920.

THE ENGINEER AND THE PUBLIC.

To the Editor of Engineering.

Sir,—Your editorial entitled "The Engineer and the Public," in Engineering of the 19th inst., shows convincingly the danger of neglecting technical assistance in public administration and legislation. May I add another example to those quoted by the writer in support of his plea for public recognition of the engineer. We have recently witnessed a disastrous strike as the sequel of a series of attempts by politicians and labour leaders to solve a most complex problem of engineering, namely, the output capacity of a coalfield and the relation between this output and the wage rate.

The British public has been lulled into a feeling of security by the so-called settlement, which is in reality no more than a postponement of the evil day, characteristic of much of our recent legislation. The decision reached is mathematically unsound, for it assumes that the economic wage rate is a function of the variable "total output" and that as the total output increases, so the economic wage rate increases. This is fundamentally false, for, in certain circumstances the economic wage rate could be increased by reducing the output; *e.g.*, by closing down all mines where the seams are less than 3 ft. in width.

The economic wage rate may be a function of the fraction representing the ratio of total output to number of miners employed, but that is a very different thing from making it a function of total output alone. Nor is this correction by itself sufficient to give a basis for calculation, because, in any mine, the wage rate is determined by many variables, such as geological conditions, efficiency of plant and skill of management. To discover a formula which will give the uniformity demanded by the trade unionist and fix a rate applicable to all the mines in the country, notwithstanding their infinite variety, is a task beyond the powers of any engineer, but something more logical than the present formula could surely have been devised.

Had our legislators decided that the wage rate should vary directly with the number of men with red hair employed in the industry, the unreasonableness of the suggestion would have been obvious to everyone, but it has just as much mathematical justification as the formula now adopted.

Yours faithfully,

D. Adam.

"VIBRATION."

To the Editor of Engineering.

Sir,—I notice that in Engineering, of the 12th inst., you print a paper which I read before the Manchester Association of Engineers on "Vibration." I am sorry that you have used an advance copy, which was marked "subject to revision," and did not submit your proof to me. Unfortunately there is an error in one of the formulæ, which was corrected at the meeting. The expression which is given as:—

$$54.2\sqrt{\left(\frac{10\times 1.5\times\frac{12}{3.3}}{20\times(1.5)^2}\right)}=60$$

should be

$$54.2\sqrt{\left(\frac{10\times 1.5\times\frac{18}{3.3}}{20\times(1.5)^2}\right)}=73$$

I should be glad if you would mention this correction in your next issue.

Yours faithfully,

J. Frith.

33, Brazennose-street, Manchester, November 17, 1920.

[We regret that the above letter, owing to its being wrongly addressed, did not reach us in time for publication in our last issue.—Ed. E.]

THE PHYSICAL SOCIETY OF LONDON.

At the meeting of the Physical Society of London held on November 12, at the Imperial College of Science, Professor Sir W. H. Bragg, F.R.S., President, in the chair, a paper on "*Ionisation and Excitation of Radiation by Electron Impact on Helium*" was read by Dr. F. H. Goucher. Of this paper the following is a summary: Measurements have been made of the critical potentials for helium by the method used in the experiments of Davis and Goucher, these being compared with the ionising potential of mercury vapour taken as a standard. Assuming the ionising potential of mercury to be 10·4 volts, two critical potentials occur in helium. One at about 20 volts and the other at about 26 volts. These critical values agree well with those obtained by Horton and Davies. The effect of radiation alone on the metal parts of the apparatus was studied under conditions which would yield evidence of use in the interpretation of the results obtained when the production of both ionisation and radiation was taking place simultaneously. The conclusion was reached that the lower critical potential was a radiation potential, though some ionisation was produced also at this potential. This, however, was attributed to the presence of impurity, probably hydrogen. The higher critical potential was that at which ionisation took place.

Discussion.—Mr. B. S. Gossling discussed at some length the effect of impurities on the lowering of the ionisation potential, illustrating his remarks with curves shown on the screen. A full account of his remarks will appear in the "Proceedings." The president asked if argon behaved in a similar way as regards the effect of impurities. Mr. Gossling mentioned that Stead's values for argon were also low, but whether this was due to impurities or not he could not say.

The President asked if these critical potentials corresponded to the production of lines in the spectrum of the gas. Dr. Goucher said the radiation potential did correspond to a line. In mercury, for instance, the radiation potential was 4·9 volts, which, as McLennan had shown, corresponded to the production of a single line in the mercury spectrum. The many-lined spectrum was produced when the potential was at or above the ionisation potential. He thought Mr. Gossling's curves were of considerable importance.

A paper entitled "*The Location of Interference Fringes*" was read by Mr. J. Guild. This paper treats of the conditions under which interference fringes, produced by reflection of light from the two surfaces of a "thick plate" are visible to an observer. The treatment lays stress on the physical significance of the term "location" as applied to interference fringes, and the dependence of the observed phenomena on the conditions of observation. For a broad source of light a formula is obtained which is equivalent to that derived by Michelson. For a joint source of light at infinity, it is shown that the fringes obtainable are equally visible at all distances from the plate.

A paper, entitled "*Fringe Systems in Uncompensated Interferometers*," by Mr. J. Guild, was taken as read, on account of the lateness of the hour. The paper mainly consists of an investigation of the form of the fringe system observable at infinity, or in the focal plane of a telescope, when a broad source is employed with a Michelson interferometer, in which the glass paths of the two interfering beams are not equal. The fringes may be elliptical or hyperbolic, with circles and straight lines as special cases. In the recently-developed method of using the instrument for optical testing, the fringes due to a joint source at infinity are employed. It is shown that the form of the fringes in this case are unaffected by lack of compensation, but that the visibility of the fringes is conditional by the nature of the fringe system due to a broad source. Mr. F. Twyman, of Messrs. Adam Hilger, Limited, made a written communication on this paper which will be published in the "Proceedings."

A paper on "*A New Relay for Heavy Currents*" was read by Dr. Guy Barr. In this paper it is stated that the action of the relay depends on the fact that no arc can be maintained between mercury electrodes in hydrogen. One lead is brought to mercury contained in a vertical tube within a solenoid. An iron rod, at the upper end of which is a glass cup, floats in the mercury. The cup also contains mercury, and the other lead is connected to an iron rod which dips into this. When no current flows in the solenoid, the rim of the cup is about 1 cm. above the level of the main body of mercury. When the relay current (about 0·03 ampere) is running the iron rod is sucked down until the rim of the cup is submerged by about 0·5 cm. The space above the mercury contains hydrogen. The relay can be used to break quite large currents (20 amperes) without much spark.

In the discussion which followed Mr. C. C. Paterson asked on what voltage the apparatus would work, as the energy in the spark would depend on this. Dr. Barr said he had not tried it above 100 volts.

Mr. F. E. Smith suggested as a simplification that a U-tube might be employed, in one limb of which was the iron float. When this was sucked down the rising mercury in the other limb of the U could make connection between two iron electrodes. Dr. Barr said it was important that the break should take place between mercury surfaces, otherwise the mercury got contaminated.

Mr. Guild suggested that if the mercury in the second limb of the U were made to flow over and make connection with some stationary mercury in a side tube the difficulty of Mr. Smith's arrangement would be overcome. Mr. Paterson asked how hot the apparatus would get if the current were broken as frequently as, say, 10 or 20 times per minute. Dr. Barr replied that he had not had occasion to try it as rapidly as that.

Dr. Hopwood asked if the break was "clear," or if the oscillations set up in the mercury were sufficient to make and break the current after the first break had occurred. Dr. Barr said there was no evidence of this. There was very little disturbance of the mercury in actual practice.

Institution of Automobile Engineers.—We are asked to announce that the annual dinner of the Institution of Automobile Engineers, which was postponed from October 27, on account of the coal strike, will now be held on January 26, at 7.30 p.m., at the Royal Automobile Club.

Motor Boat and Marine and Stationary Engine Exhibition, 1921.—We are informed that the Society of Motor Manufacturers and Traders has decided not to proceed with the above exhibition, which it was proposed to hold at Olympia in March next, but to consider the inclusion of a marine section at their 1921 Motor Exhibition.

150-TON FLOATING CRANE FOR THE UNITED STATES NAVY.

CONSTRUCTED BY THE WELLMAN-SEAVER-MORGAN COMPANY, ENGINEERS, CLEVELAND, OHIO, U.S.A.

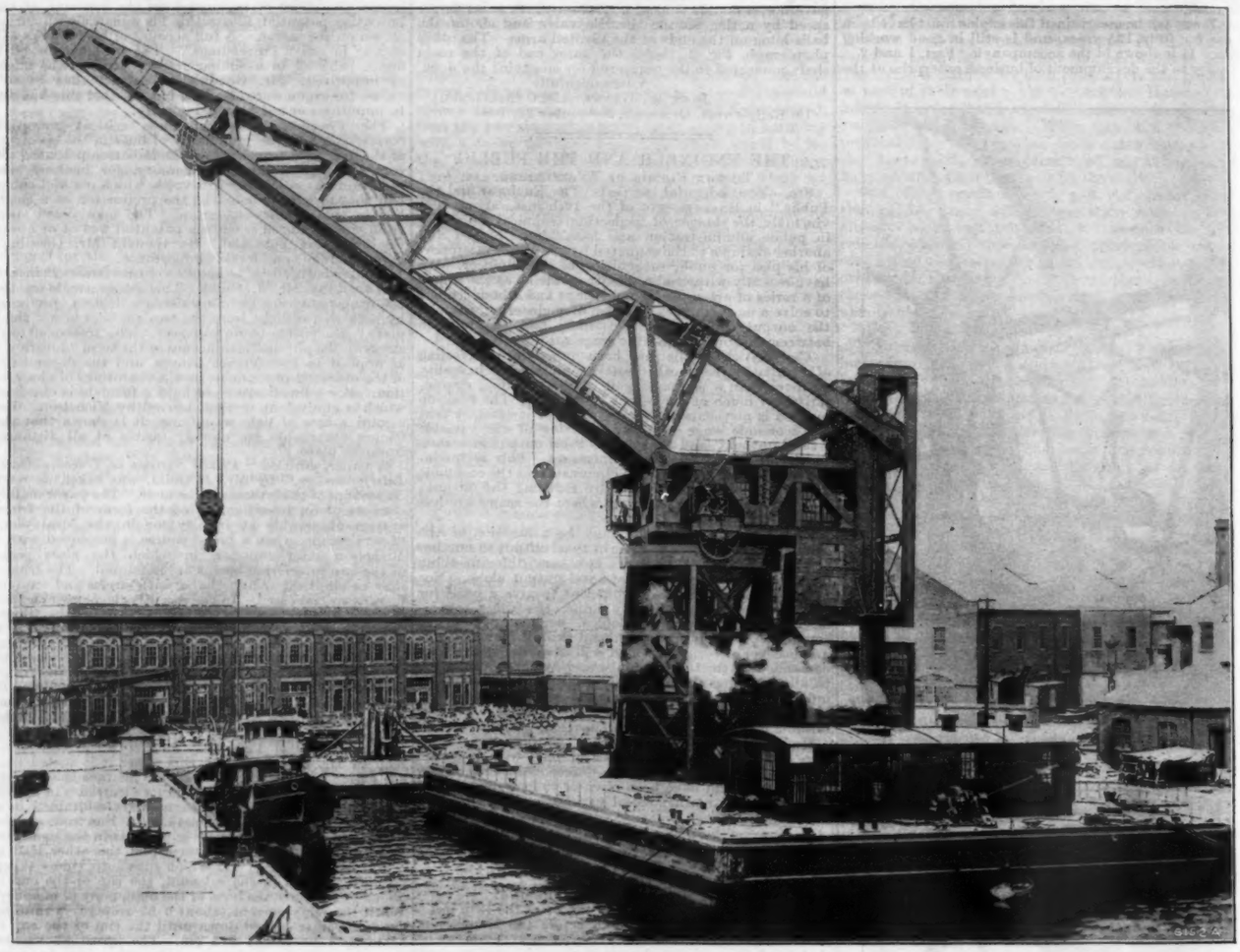


FIG. 3.

Two floating cranes of 150 tons capacity have recently been built for the United States Navy yards at Norfolk, Va., and Mars Island, Cal., by the Wellman-Seaver-Morgan Company, Cleveland, who are represented in this country by the Wellman-Smith-Owen Engineering Corporation, Limited, King's House, Kingsway, London, W.C. 2. In Figs. 1 and 2, Plate LXX, and Figs. 3, 4 and 5, on the present and opposite pages, we give illustrations of the crane installed at the Norfolk yard. These cranes are designed to handle 150 (short) tons at a radius of 105 ft., and with the load a maximum lift above water level of nearly 96 ft. is arranged, with an additional range below water level running to 25 ft., giving a total lift of 121 ft. from lowest to highest position of the hook of the block.

Each crane is carried on a pontoon having a moulded length of 140 ft. and breadth of 85 ft. The centre of the pintle is placed 42 ft. from one end. The pontoon is provided with longitudinal and transverse bulkheads, with full depth collision compartments all round it. Compartments for the boiler plant and generating set are provided aft and suitably housed in. The crane revolves in a steel tower 43 ft. high, fixed to six of the bulkheads. The revolving structure consists of the jib and platform, and the pintle section, the latter being contained in the tower, as will be seen from our illustrations. On the opposite side from the jib, which is hinged to the platform at a level 60 ft. above the deck, is an extension frame carrying the luffing crossheads and guides, and all the machinery. The pintle rests in a step bearing on the deck. It is supported at the head of the tower by a horizontal roller bearing ring of 60 cast steel rollers in a circular ring. On the top of the tower is a bevel ring, 29 ft. in diameter. Two bevel pinions carried by the revolving structure, and driven by motors through reduction gears, mesh with this ring and revolve the jib under maximum load at the rate of one complete revolution in 4 minutes. The two motors are each 40-h.p., series wound, and fitted with an electrically-operated disc brake. The reduction gears may be seen in the drawings and photographs.

The jib is luffed by screw-operated crossheads which travel in vertical guides at the back of the extension of the revolving structure. The jib is 125 ft. long, and when in its highest position the total height is 190 ft. above water level. The vertical movement of this jib is controlled by two 40-h.p. series-wound motors driving through bevel and spur gearing. The thrust on the screws is taken by two conical roller bearings, each of which is designed to take a load of 450,000 lb. The screws are of forged steel, 9½ in. diameter and about 52 ft. long, giving a travel for the crossheads of 37 ft. Luffing from the lowest to the highest position occupies about 15 minutes, the reverse operation taking 11 minutes.

The main hoist consists of two 75-ton blocks coupled together. The hoisting gear comprises, for each block and cable, a 40-h.p. series motor driving a winding drum through three sets of reduction spur gears, fitted with an electrically-operated disc brake mounted on the motor pinion shaft. This brake acts automatically when the current to the motor is cut off. There is also a mechanically-operated band brake on the intermediate shaft, for emergency use. This can be seen in Fig. 5, which gives a view of the interior of the motors room for the main hoist. The gearing is designed for a speed of 4 ft. per minute for the 150-ton hoist, or 8 ft. per minute when either block is under half load. The position of the hoisting motor room is indicated in Fig. 1. The main hoisting cables are 1¼ in. The jib carries an auxiliary 25-ton block, which can be traversed on the jib over a range of 109 ft. 7 in. The winding gear for this is located just above that for the main hoist (Fig. 1). It consists also of a 40-h.p. series motor with selective speed gears giving a range of 12 ft. for a 25-ton load up to 60 ft. for a 5-ton load. This gear is also fitted with a disc brake. The auxiliary trolley is traversed up and down the jib by a 40-h.p. motor situated at the back of the upper platform above the roller ring level. When the jib is in the nearly vertical position, this hoisting gear has, of course, to take practically the whole load, and under these conditions the load is raised by moving the trolley.

The pontoon is fitted with four electrically-driven capstans located near the corners, and also with two steam-driven winches, and the necessary chocks, fair-leads, &c. The total floating weight of the crane is 2,600 (short) tons.

THE LATE MR. FREDERICK LISTER CROFT.—We regret to have to announce that Mr. Frederick Lister Croft died suddenly at his Morecambe residence on November 5, after being in bad health for a long time. Mr. Croft was born in Bradford on September 30, 1857 and, except, for a short sojourn in America, he lived in Bradford all his life. Mr. Croft commenced working quite young in life. When only 29 years of age, he founded the firm of Crofts (Engineers), Limited, specialists in power transmissions, Bradford. The original capital was very small and the staff at first consisted of only four men; the business grew by his efforts until it now employs well over 1,000 hands. These works, in fact, are a lasting memorial to his great abilities. Mr. Croft was a member of the Institution of Mechanical Engineers since 1903.

150-TON FLOATING CRANE FOR THE U.S. NAVY.

CONSTRUCTED BY THE WELLMAN-SEAVER-MORGAN COMPANY, CLEVELAND, OHIO, U.S.A.

(*For Description, see opposite Page.*)

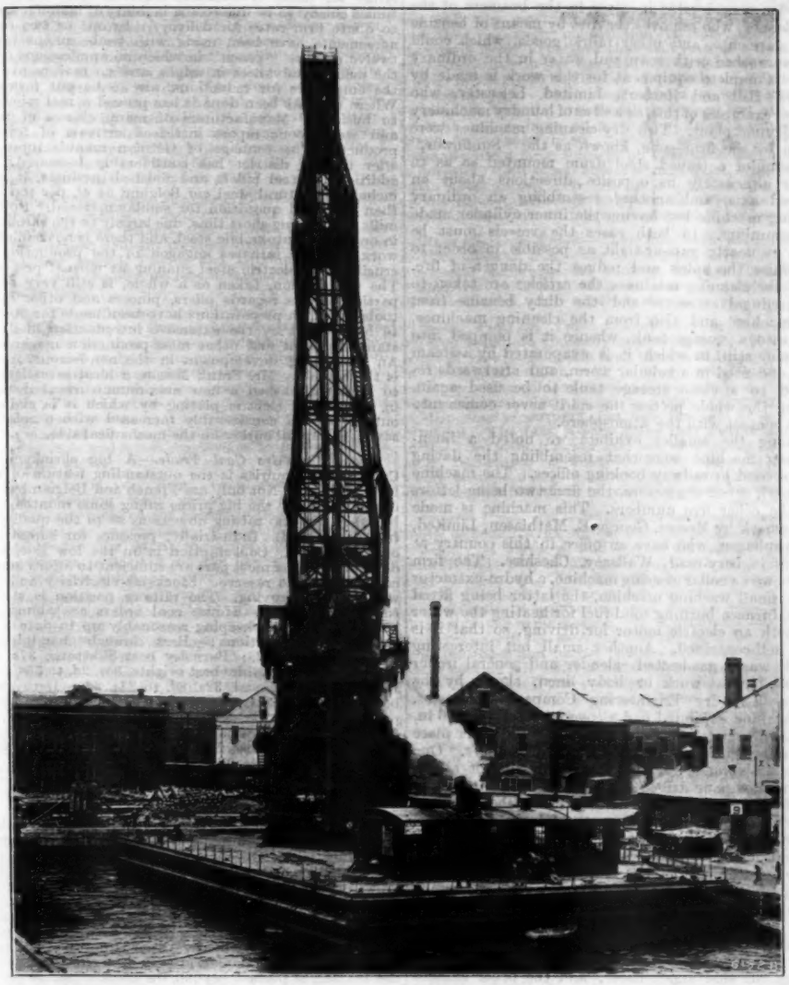


FIG. 4.

FIG. 5.

THE LAUNDRY EXHIBITION.

WHEN it is remembered that the seven years that have elapsed since the last exhibition of laundry machinery and supplies have been almost entirely occupied by the war and its after effects, it is perhaps not surprising that no very remarkable developments were in evidence at the exhibition which closed on Wednesday last at the Royal Agricultural Hall. This exhibition, which was promoted by the Society of Laundry Engineers and Allied Trades, Limited, was described as international, but foreign exhibitors were particularly few and far between; we only noticed one foreign firm. It was, however, a fairly representative collection of British laundry machinery, since the majority of the important firms in the industry displayed their products. Many of these were of considerable interest to engineers in general, but the space at our disposal will only permit a reference to a few of the more noticeable exhibits.

Among such items was a large Decoudun ironing machine which the makers, Messrs. Manlove, Alliott and Co., Limited, Nottingham, describe as their "L" type. The machine shown had a roller 108 in. long by 42 in. in diameter, the latter dimension, we believe, being the largest in the exhibition. The roller and bed of this machine are both of cast-iron and both are steam heated. The bed is cast with five internal ribs dividing it into six pockets, the object of the ribbing being to prevent distortion owing to expansion. To enable the bed to be cleaned when necessary, the roller can be raised by power-driven screw gear clear of the bed and then rolled back horizontally on the frame of the machine so as to expose the bed completely. The roller is driven by worm gearing, which eliminates all trouble due to the chattering sometimes experienced with spur gearing. When spur gearing is necessary for driving ironing machines the firm use driving wheels at each end of the roller to prevent chattering. All ironing machines are fitted with guards to prevent the operator's fingers from being drawn in with the work. The guard, in the machine we are considering, consists of a metal strip extending along the whole length of the roller, pivoted at each end and connected with a special form of coil clutch. If the operator's fingers approach the roller too closely the plate is tilted and the clutch thrown out, thus stopping the machine. The guard, in this case, is actually fitted with handles and forms the normal means of stopping and starting the machine, so that if it should get out of order attention is immediately drawn to the fact. The machine weighs 9 tons, and will dry and finish 120 to 150 full-size table cloths per hour. It may be interesting to mention here that Messrs. Manlove, Alliott, first introduced the Decoudun ironer more than fifty years ago, and were the original patentees, in 1835, of centrifugal machines for separating molasses from sugar. Their exhibit included a number of examples of centrifugals, or hydro-extractors as they are usually called by laundry engineers, all the machines shown being of the under-driven type with ball bearings; one small machine exhibited was intended to be used for extracting the surplus starch from collars, &c. The firm also showed washing machines and smaller ironers than the large machine above referred to.

The exhibit of Messrs. Thomas Bradford and Co., Salford, Manchester, included similar plant to that above described, but its most noticeable feature was a large ironing machine having two rollers, 24 in. in diameter and 150 in. long, both steam heated. This machine, which is known as the "Unicourse" from the fact that the work need only be passed through it once, is provided with a band-feeding device consisting of a number of canvas bands, each about 3 in. wide, placed close together laterally on two long rollers which are rotated to drive the bands. The bands are supported by a curved steel plate placed under them to prevent sagging from the weight of the work or the pressure applied by the operator. To remove the work from the first roller and deliver it on to the second, stripping tapes, about ½ in. wide, and placed 9 in. or 10 in. apart, are provided on the former. Each tape has an independent tension weight, which is obviously a more satisfactory arrangement than the older method of using a single weight to tension all the tapes. An important feature in the design of the machine is the fact that it can be fed from the ordinary ground level without a platform. We understand that it has been largely used in the laundries of shipping companies, its advantage for this class of work being that two ship's table cloths can be passed through simultaneously side by side. On smaller work, such as table napkins, with five girls feeding the machine an output of 3,000 per hour has been reached. The firm also showed smaller ironing machines, hydro-extractors and washing machines, the latter being fitted with a safety device to close the lid of the inner chamber automatically if the machine should be started by accident with the lid open. One of the hydro-extractors exhibited is intended for use in

asylums and other similar institutions, and is fitted with a hinged wire guard over the opening through which the cage is filled and emptied. The machine is driven by a bevel friction gear, and the act of starting it, by bringing the two parts of the friction gear into contact, locks the guard so that it cannot be opened while the machine is in motion. Two other firms, who exhibited hydro-extractors and other centrifugal separating machines only, should be mentioned, viz., Messrs. Watson, Laidlaw and Co., Limited, Glasgow, and Messrs. Thomas Broadbent and Sons, Limited, Huddersfield.

A good selection of laundry machinery, including washers, ironers, hydro-extractors, shirt and collar finishing machines, gas compressors and gas-heated irons, was shown by Messrs. Aublet, Harry and Co., Limited, Curtain-road, London, E.C. 2, who have recently taken over the laundry-machinery business of Messrs. Summerscales, Limited, Keighley. We can, however, only refer briefly to one or two of the firm's exhibits, of which perhaps the most important was their 108-in. by 24-in. Decoudun ironer. This machine is driven at each end of the roller by worm and spur gearing, and two speeds are provided to deal with different classes of work. To enable the roller to be raised clear of the bed at meal times, and also to allow an article which may have caught by being carelessly fed into the machine to be released, a shaft on which two eccentrics are mounted is fitted under the roller. The eccentrics are each connected to the main bearings of the roller, and the shaft can be driven by worm gearing put into operation by a friction clutch, so that, by throwing in the latter, the roller can be easily and quickly raised sufficiently for the purpose, but no harm can result if the operation is continued longer than necessary. Mention should also be made of a six-roller ironing machine with rollers 108 in. long by 12 in. in diameter. This machine, which was designed by Messrs. Summerscales, and goes by the trade name "Monarch," is fitted with a two-speed gear and a ribbon feed, and is capable of taking flat work directly from the hydros and finishing it completely in one operation. The rollers are arranged horizontally one behind the other, and each works in a curved steam-heated bed, but the rollers themselves are not supplied with steam.

A machine of the same type and dimensions as that last mentioned was also shown by Messrs. D. and J. Tullis, Limited, of Clydebank, N.B. This machine, in addition to six ironing rollers working in steam-heated beds, has two additional airing rollers at the rear end which, however, do not add materially to the floor space required. The two airing cylinders are steam heated, and one of them is 12 in. and the other 30 in. in diameter. After passing under the six ironing rollers, the articles pass round the two airing cylinders, with which they are kept in contact by means of travelling bands and sheets, and with a feeding rate of 48 ft. per minute, they leave the machine ready for immediate use. In addition to a number of hydro-extractors and washing machines of the usual horizontal cylindrical type, this firm also showed a new type of washing machine especially designed for washing flannels and delicate silk articles liable to be injured by the ordinary washing process. In this special washing machine a vertical shaft supported by an overhanging frame carries at its lower end three conical plungers of galvanised sheet steel. The shaft is given a vertical reciprocating motion by means of a crank, and, after each stroke, is rotated through a small angle in the horizontal plane. An open galvanised steel tub containing the goods to be washed is placed under the plungers, which are then set in motion, and the washing action is greatly augmented by the design of the plungers, which is such as to promote the circulation of the water through the fabric. Spring buffers are fitted on the shaft to render the action of the plungers more gentle.

Drying is, of course, a most important part of laundry work, and many appliances to facilitate the process were included among the exhibits. An arrangement which appears to combine the features of simplicity and efficiency to an unusual extent, was shown by Messrs. W. W. Wardle and Sons, 79, Queen's-road, Finsbury Park, London, N., and is known as the "Wardle" continuous drying machine. It comprises a rectangular chamber constructed of timber framing and measuring 10 ft. 6 in. long, 9 ft. 7 in. wide and about 7 ft. 6 in. high. Inside the chamber, near the roof, are three horizontal link belts running from the front to the back of the chamber, and extending slightly through an opening in the front end wall. The three belts are connected by a number of specially-shaped wooden rods placed at intervals of about 6 in. apart, and each rod carries a number of galvanised iron clips. The articles to be dried are placed under these clips by operators standing outside the chamber, and as each rod is filled with clothes the chain sprockets are turned by hand so as to carry the clothes into the chamber. As the process is continued they travel slowly through the chamber, hanging down vertically, to the back, where the clips automatically release them and allow them to fall on to a table. The drying is effected by air heated by steam coils to about 130 deg. F., and forced into the chamber by a fan; fans are also used to circulate the air in the chamber before it escapes to the outlet.

The present high cost of clothing has, we understand, caused a considerable increase in the business of the dry cleaner, who removes the dirt by means of benzine from garments, and other fabric goods, which could not be washed with soap and water in the ordinary way. Complete equipment for this work is made by Messrs. Hill and Herbert, Limited, Leicester, who showed examples of this, as well as of laundry machinery and drying plant. Two dry-cleaning machines were shown by the firm—one, known as the "Sunflower," consisted of a tinned steel drum mounted so as to rotate alternately in opposite directions about an inclined axis, and another resembling an ordinary washing machine but having the inner cylinder made of aluminium. In both cases the vessels must be made as nearly vapour-tight as possible in order to economise the spirit and reduce the danger of fire. From the cleaning machines the articles are taken to a centrifugal extractor and the dirty benzine from this machine and also from the cleaning machines, runs into a storage tank, whence it is pumped into a benzine still, in which it is evaporated by a steam coil, condensed in a tubular worm, and afterwards returned to a clean storage tank to be used again. During the whole process the spirit never comes into direct contact with the atmosphere.

Among the smaller exhibits we noted a linen-marking machine somewhat resembling the dating stamps used in railway booking offices. The machine will mark seven characters, the first two being letters and the other five numbers. This machine is made in Denmark by Messrs. George E. Mathiasen, Limited, of Copenhagen, who have an office in this country at 10B, Stringbery-road, Wallasey, Cheshire. The firm also showed a collar glossing machine, a hydro-extractor and a small washing machine, the latter being fitted with a furnace burning solid fuel for heating the water and with an electric motor for driving, so that it is quite self-contained. Another small but interesting exhibit was a gas-heated calender and general ironer suitable for flat work or body linen, shown by the Magnus Laundry Engineering Company, Leicester. The machine exhibited had a covered solid roller, 6 in. in diameter and 3 ft. 6 in. long, and a flat steel plate bed under which was situated a row of gas jets. One advantage claimed for the flat bed is that it allows the water vapour driven off from the work to escape at once instead of imprisoning it in the covering material of the roller, as happens with the more usual curved form of bed; the covering material, it is claimed, has a longer life in consequence.

The greater part of the machinery and appliances exhibited were shown in operation, the necessary steam and mechanical power being supplied from the stand of Messrs. Davey, Paxman and Co., Limited, Colchester, who showed a locomotive-type boiler under steam and a 20-h.p. horizontal compound engine driving the shafting. These, and the other engines and boilers exhibited by the firm, are, however, well known to most of our readers.

Fuel Oil Regulations for Ships.—We have received from the British Corporation for the Survey and Registry of Shipping the following addition to their regulations in connection with the carriage of fuel oil in tanks: Section 40, paragraph 1. Where fuel oil is carried in thwartship hold tanks adjacent to coal bunker or cargo spaces, the pipes which pass through the oil tank and are not protected by a satisfactory oiltight tunnel, are to be of wrought-iron or steel, and efficiently protected in the tank from damage by cargo; the bilge suction pipes which pass through the tanks are to have non-return valves; the tank suctions are to have screw-down valves on the bulkhead, the control of which is always accessible. The valves are to be so arranged as to prevent the passage of oil from the tank in the event of damage to the suction pipes.

Institution of Municipal and County Engineers.—A joint meeting of the Metropolitan and Eastern District Sections of the Institution of Municipal and County Engineers has been arranged for Friday, December 3, to be held at High Barnet. The programme will be as follows: Members will assemble at the Municipal Offices, Wood-street, High Barnet, at 11.15 a.m., when the offices, &c., will be inspected, after which a visit of inspection will be paid to workmen's dwellings, the sewage farm, tarred macadam roads constructed in 1914, and asphalt roads now under construction. Lunch will be at 1 p.m., after which a paper will be read by Mr. W. B. Chancellor, engineer and surveyor to the Barnet C.D.U. Tea will be provided at 4 p.m. Members intending to be present are requested to communicate at once either with Mr. E. Y. Harrison, borough engineer, Ipswich, or Mr. E. F. Spurrell, borough engineer, 197, High Holborn, W.C.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—Unusually mixed conditions prevail. Instances of great pressure and marked slackness are to be found side by side, but easier conditions are the rule rather than the exception. New business is not being booked in any of the principal steel lines with the freedom that is customary at this time of the year, either for home or overseas requirements. This continues chiefly to be due to the inability of manufacturers to quote firm rates for delivery. In one or two cases agreements have been made with trade unions for a twelve months' "peace" in which no applications from the men for advances in wages, and no movements by the employers for reductions, are to be put forward. Where this has been done it has proved a real stimulus to business. Manufacturers of many classes of steel and steel goods report increased arrivals of foreign products. The tonnage of German manufactures on offer in this district has considerably increased. In addition to steel billets and finished products, it now includes structural steel *via* Belgium at 4*l.* per ton less than the local quotation for similar material. Rolling mills are working short time, due largely to the shrinkage in orders for automobile steel, and there is not sufficient work to keep furnaces engaged in the production of crucible and electric steel running at normal pressure. The tool section, taken as a whole, is still very busy, particularly as regards pliers, pincers and other hand tools, in which preparations have been made for output to be doubled by the extensive introduction of drop-stamping plant and other mass-production machinery. An interesting development in the non-ferrous trades is the claim by Mr. Frank Mason, a local investigator, to have established a new maximum current density in commercial electric plating by which it is claimed output will be considerably increased with a relative saving in capital outlay on the mechanical side.

South Yorkshire Coal Trade.—A big shrinkage in Continental inquiries is the outstanding feature of the local position. Not only are French and Belgian buyers declining to pay the big prices ruling some months ago, but they are also raising objections as to the quality of fuel despatched. Industrially, pressure for supplies is only moderate. Consumption is on the low side, and deliveries for the most part are sufficient to afford ample contributions to reserve. Stocks at electricity and gas works are improving. The railway position is stated to be satisfactory. House coal orders are abundant, but merchants are keeping reasonably up to date with deliveries. Quotations:—Best branch handpicked, 37*s.* 2*d.* to 38*s.* 2*d.*; Barnsley best Silkstone, 37*s.* 2*d.* to 37*s.* 8*d.*; Derbyshire best brights, 35*s.* 2*d.* to 36*s.* 2*d.*; Derbyshire house coal, 32*s.* 8*d.* to 33*s.* 2*d.*; Derbyshire best large nuts, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire small nuts, 31*s.* 8*d.* to 32*s.* 8*d.*; Yorkshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; rough slacks, 28*s.* 2*d.* to 29*s.* 2*d.*; nutty, 27*s.* 2*d.* to 28*s.* 2*d.*; smalls, 23*s.* 2*d.* to 24*s.* 2*d.*

Growth of Grey Cast-Iron.—The increase in volume which is observed in grey cast-iron when repeatedly heated, is frequently ascribed to oxidation. According to M. Okôchi and N. Satô (Journal of the Tokyo College of Engineering, 1920, pages 53 to 71), the growth is rather a question of the dilatation of occluded gases. Heating in air gives rise to a partial oxidation and to a slight volume increase, but the main growth is due to other causes, since it is observed in hydrogen and even in a vacuum as well as in air. Apart from the first heating of a sample, permanent growth does not occur unless the heating is pushed beyond the transformation point. Above 650 deg. C. the cementite is decomposed and carbon separates; this carbon is easily oxidisable, and the gas formed may escape. When iron is heated above the transformation point it expands owing to the dilatation of the occluded gases and the lowering of the yield-point of the iron; during the transformation there is also growth due to the same gas expansion, but this growth is counteracted by the change of α iron into γ iron. The free carbon (graphite) is essential for the growth; in white iron free carbon is absent, and there is no room for the expansion of occluded gases, nor for the penetration of the gases along flakes of graphite.

Photography of Coloured and Distant Objects.—In his presidential address delivered to the Society of Chemical Industry last month, Sir William Pope, F.R.S., of Cambridge, dealt with the problems of the photography of coloured and distant objects. We have on other occasions drawn attention to the importance of the sensitisers in the green-red (pinaverdol) and in the red (pinacyanol). Both these dyes were the invention of the firm of Meister, Lucius and Brüning, but Sir William Pope and Dr. W. H. Mills have of late, by preparing more than 50 substitution products of these dyes, done much to clear up the constitution of these bodies. The nature of their effect remains obscure; they have shown at any rate, however, that the silver salts (bromide, &c.) absorb the dyestuff, and that the position of the maximum absorption bands in the spectra changes with the dye. As regards distant vision, a plate sensitive only to blue and violet becomes ill-defined owing to the atmospheric absorption and diffusion of these rays coming from distant objects; when a red filter is interposed between the lens and the object, the photograph shows much better definition. The best panchromatic plates now commercially made in this country require less exposure for red than for blue; the opposite was true formerly, and through a pure red screen aerial photographs can now be taken with exposures of 0·01 second.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Quite a number of blast furnaces are now running satisfactorily, but several are still working irregularly, and output continues to consist of an abnormally large proportion of the lower grades of pig-iron, of which there is already quite a glut. Home demand for forge, mottled and white iron is only very moderate, and foreigners cannot be induced to take these qualities. Foundry pig-iron is exceedingly scarce, so much so that hardly any is purchaseable for home use, and none can be spared from abroad. A suggestion that monthly allocations of foundry iron should be discontinued, meets with favour. The system was adopted as a temporary measure, and the allotments have dwindled to trifling quantities. A free market, when there is any iron obtainable, would doubtless be more acceptable to traders. For home consumption, No. 1 Cleveland pig-iron is 237*s.* 6*d.*, and No. 3 and the commoner qualities all stand at 225*s.*

Hematite.—The position as regards East Coast hematite iron shows no change. Little or none is to be had for early delivery, but makers offer mixed Nos. freely at 260*s.* for forward delivery to home customers. Foreign demand has ceased, France and Belgium being self-supporting and the adverse rate of exchange prohibiting trade with Italy.

Foreign Ore.—Transactions in foreign ore are few and small just now, but there is some prospect of renewal of business in the near future. Consumers do not need to buy to meet early requirements as they have considerable stocks, but several of them are by no means disinclined to discuss arrangements for next year's supplies. The c.i.f. Tees value of best rubio is in the neighbourhood of 51*s.*, as it is understood that purchases can be made at 49*s.* on the 17*s.* parity freight Bilbao-Middlesbrough, and latest charterings from the Spanish ore port are at 19*s.*

Coke.—Coke is very firm. Local needs are heavy and are receiving fairly satisfactory attention, but consumers are pressing for increased deliveries as they are anxious to accumulate stocks. Medium blast-furnace kind is 62*s.* 9*d.* at the ovens, and quality low in phosphorus is 65*s.* 3*d.* at the ovens. There is no export business passing in coke.

Manufactured Iron and Steel.—There is very little passing in finished iron and steel. Contrary to expectation, steelmakers have not reduced prices, and new business is difficult to arrange, as it is generally held that values will have to fall before extensive sales can be looked for. Common iron bars are 30*l.*; marked bars, 32*l.*; iron angles, 30*l.* 15*s.*; steel bars, 24*l.*; steel ship, bridge and tank plates, 24*l.* 10*s.*; steel angles, 24*l.*; steel boiler plates, 31*l.*; steel joists, 24*l.*; steel strip, 30*l.*; channels and flats, 24*l.* 5*s.*; rounds and squares, 26*l.* 10*s.*; soft billets, 22*l.*; medium billets, 23*l.*; hard billets, 24*l.*; heavy sections of steel rails, 25*l.*; fishplates, 30*l.*; black sheets, 30*l.*; and corrugated galvanised sheets, 36*l.*

CHURCHWARD-BETHLEHEM SUIT ON NICKEL-CHROME-VANADIUM STEELS.—In the case of Churchward International Steel Company *versus* Bethlehem Steel Company, the United States Circuit Court of Appeals for the Third Circuit, on appeal from the District Court for the Eastern District of Pennsylvania, has decided that the claims of the patents involved in the suit are invalid for want of patentable invention, and has directed the trial court to enter an order dismissing the bill, thus reversing the decree of the District Court, says *The Iron Age*, New York. This suit was begun in October, 1915, by the Churchward International Steel Company, alleging infringement of two United States patents, Nos. 845,756 and 868,327, issued to James Churchward, covering nickel-chrome-vanadium steels, and damages were asked to the amount of 2,000,000 dols.

THE LATE DR. ING. C. O. GLEIM.—Mr. Charles Otto Gleim, who died in Hamburg on November 2, in his 77th year, after long illness, was an American by birth, but was trained in the Technical High School at Karlsruhe, and had spent practically all his life in Europe, where he became an authority on the design and construction of railway stations. He made his name by his share in the construction of the two large bridges crossing the Elbe between Hamburg and Harburg. Northern Europe was the main field of his activity. The new or enlarged stations of Petrograd, Helsingfors and Viborg, Stockholm, Upsala, Gefle, Malmö Gefle; Kristiania and Copenhagen were built to his designs. But his activity extended all over Germany and into Switzerland. His college town of Karlsruhe, and also Darmstadt, Göttingen, Braunschweig, Osnabruck and Mülhausen (in Alsace) consulted him about their extensions and railway connections; he also built some of the local railways of the Hamburg district and was connected with their management. In Switzerland he was partly responsible for the new stations of Bern (1915) and Lucerne, and of Zürich, both the central stations of 1897 and 1918–19, and the railway on the left shore of the Lake of Zürich. In recognition of his great and original share in the remodelling of German railway-station construction, the Technical High School at Dresden created him a Doctor of Engineering; he was one of the first on whom the much-coveted degree of Dr. Ingenieur was conferred *honoris causa*. Gleim was a corresponding member of the American Society of Civil Engineers. He was well known at engineering congresses, where his dignified bearing and wide knowledge and experience secured him esteem.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—The various Scotch steel works are now getting back to normal conditions after the disastrous effects of the strike in the coal trade and output is again improving. Plate mills are busy, and there is a steady demand from shipbuilders, but there is not so much doing in sectional material. The recent reduction in prices is inducing a certain amount of fresh business, but buyers are rather shy in a falling market and only the most urgent lines are being given out meantime. Foreign competition is very keen, and opinion is freely expressed that still further reductions will be necessary in the near future in Scottish quotations if order books are to be filled up sufficiently to provide for forward outputs. Black sheet makers are well occupied at present, but the recent fall in prices has not yet brought out as large an amount of fresh business as would have been liked. At the moment, however, there is quite a large tonnage on order, and the outlook is hopeful. Galvanised sheets remain quiet, with prices again much softer. The export side of the steel trade moves slowly, although shipping facilities are much better of late, and a little improvement is noticeable.

Malleable Iron Trade.—There has been little change in the malleable iron trade of Scotland during the past week and all works are running steady. The home business is good, and there is a satisfactory amount of work booked, while export is also increasing.

Scotch Pig-Iron Trade.—Conditions in the Scotch pig-iron trade are generally improving from the output point of view, and before long there will be an increase in production which will be very satisfactory and welcome. Meantime all grades continue scarce, foundry iron being particularly so, and no difficulty is experienced in disposing of outputs, but new business is not over plentiful. The fact is very plain that buyers are disinclined to book forward and are only fixing up their more immediate necessities. Prices are unchanged. There is little doing in export, as after the home consumer is satisfied there is practically nothing left over.

General Conditions.—Business is once again becoming more difficult to fix up on account of the downward tendency of markets, and buyers all round—at home and abroad—are undoubtedly holding back as long as they possibly can. The dealings which have taken place during the past week or so are for the most pressing requirements of consumers, and current inquiries are largely of the same nature. It is generally considered that prices will fall as rapidly as they advanced, but so long as wages and oncost charges are unaltered quotations cannot fall other than slowly. With the smaller fresh demand of the past few months and a steady output the majority of order books are fairly lean now, and although there is quite a lot of work on hand yet, the future is causing some anxiety to managements in the iron and steel trades. America, Belgium and France are all offering cheap material, in many cases considerably under home prices, and if new business is to be secured that competition will have to be met. The general trade of the country is certainly not what it was, but the wave of depression may be only of a temporary nature and a revival not be far off. Engineers overall are busy and have much work booked ahead, and only in one or two instances is there an actual scarcity of orders. Textiles, on the other hand, are really quiet, but signs of improvement are not wanting, although much of the trouble is caused by the financial situation abroad.

ROAD TRANSPORT AND INDUSTRIAL MANAGEMENT.—The Institute of Industrial Administration is holding a meeting at the Central Hall, Westminster, on December 7, at 7 p.m., when Mr. Richard Twelvetrees, A.M.I.Mech.E., will read a paper on "Road Transport as an Aid to Industrial Management." The chair will be taken by Mr. E. Shrapnell-Smith, C.B.E., chairman of the Commercial Motor Users' Association, and the subject will be discussed from various aspects, including the development of roads, traffic congestion, handling of goods, and the design and maintenance of road motor vehicles.

STANDARD SPECIFICATION FOR STEAM TURBINES.—On account of the new method of rating electrical generators adopted in 1917 in the British Standardisation Rules for Electrical Machinery, it has been necessary for the British Engineering Standards Association to consider the whole question of prime movers in electrical generating plant. The report on reciprocating steam engines for electrical purposes, issued in 1909, will probably require revision, but before dealing with this matter it was decided to prepare a specification for steam turbines, since these have so largely replaced reciprocating engines in power stations. This specification (No. 132—1920) has just been issued, and it has also been decided to issue a separate specification relating to oil engines. The turbine specification contains clauses dealing with such matters as rating, governing, steam consumption, measurement of steam pressures and temperatures, critical speeds of shafts, &c., and an appendix includes a dimensioned drawing of the standard thermometer pocket and also explains the method recommended for correcting thermometer readings for the error due to the exposed part of the mercury column in the stem. It can be obtained for 1*s.* 2*d.* post free, either from the offices of the Association at 28, Victoria-street, London, S.W. 1, or from Messrs. Crosby, Lockwood and Son, 7, Stationers' Hall Court, London, E.C. 4.

NOTICES OF MEETINGS.

THE BRADFORD ENGINEERING SOCIETY.—Monday, November 29, at 7.30 p.m., Meeting in the Hall of the Bradford Technical College. Mr. S. C. Brown, of Leeds, on "Modern Weighing Machinery," with lantern illustrations.

THE ROYAL SOCIETY OF ARTS.—Monday, November 29, at 8 p.m.: Cantor Lecture, "Micro-Organisms and Some of their Industrial Uses," by Mr. A. Chaston Chapman, F.R.S., F.I.C. (Lecture I). Wednesday, December 1, at 8 p.m.: Ordinary Meeting, "Embroidery: National Taste in Relation to Trade," by Miss Louisa F. Pesel, President of the Embroiderers' Guild. Sir Cecil Harcourt Smith, C.V.O., LL.D., Director and Secretary, Victoria and Albert Museum, will preside.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 30, at 5.30 p.m. Papers to be read: "On the Characteristics of Notched-Bar Impact Tests," by Mr. Thomas Ernest Stanton, C.B.E., D.Sc., F.R.S., M.Inst.C.E., and Mr. Reginald George Cyril Batson, Assoc.M.Inst.C.E.; "Notes on the Single-Blow Impact Test on Notched Bars," by Mr. Richard Henry Greaves, M.B.E., M.Sc., and Mr. Harold Moore, O.B.E., B.Sc.; "The Effect of Overstrain on the Impact Figure of Steel," by Mr. Richard Morgan Jones, M.Sc., and Mr. Richard Henry Greaves, M.B.E., M.Sc.

THE INSTITUTION OF SANITARY ENGINEERS.—Wednesday, December 1, at Denison House, Vauxhall Bridge-road, Westminster, when a Sessional Meeting will be held. Subject: "Activated Sludge Disposal," by Mr. W. H. Makepeace (Fellow). Mr. E. C. P. Monson, President, will take the chair at 6 p.m. Discussion to follow.

THE ROYAL AERONAUTICAL SOCIETY.—Thursday, December 2, at 5.30 p.m., at the Royal Society of Arts, John-street, Adelphi, London. W.C. 2. Abstracts of two papers, one by Major G. H. Scott, C.B.E., A.F.C., on "Airship Piloting," and another by Flight-Lieutenant F. L. C. Butcher, R.A.F., on "Airship Mooring," will be read. Air Marshal Sir Hugh Trenchard, K.C.B., D.S.O., will take the chair.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, December 3, at 8 p.m., at Caxton Hall. Lecturette, "Electrolysis as Applied to the Measurement of Water," by Mr. G. F. Shotter, Member.

THE SOCIETY OF ENGINEERS.—Monday, December 6, at 5.30 p.m., in the Apartments of the Geological Society, Burlington House, W. The proceedings will open at 5 p.m. with a social gathering of members and visitors, after which a paper will be read at 5.30 p.m. on "Blackpool Sea Coast Defence Works," by Mr. H. Banks, M.Inst.M. and C.E.

THE ASSOCIATION OF DROP FORGERS AND STAMPERS.—Monday, December 6, at 7.30 p.m., in the Mappin Hall, the University, St. George's-square, Sheffield, a lecture on "Forging Temperatures of Steel" will be delivered by Dr. Leslie Aitchison, D.Met., B.Sc., A.I.C. Chairman, Mr. G. H. Cowen, M.I.Mech.E.

ELECTRIC IRON SMELTING IN SWITZERLAND.—The Elektrochemischen Werke Lauffen, in Lauffenburg, are being reorganised for the electric smelting of Swiss iron ores, notably from the Frick Valley. This is one more of the experiments on the utilisation of electricity to which the dearth of coal leads in Switzerland.

GAS AND MOTOR FUEL FROM STRAW.—The Commercial Counsellor to H.M. Embassy in Washington, commenting on U.S.A. press reports relative to the production of gas and motor fuel for lighting and power purposes from straw, states that the apparatus for this purpose, which was exhibited at the Chemical Exposition in New York City in the autumn of 1918, is apparently simple and easily manageable and consists of an oven 4 ft. wide by 10 ft. long and 6 ft. high, a steel retort 18 in. in diameter and 5 ft. high, and a steel receiver 7 ft. high and 6 ft. in diameter. The pressure on the walls of the retort and tank is about 35 lb. per square inch. The aim of the invention is to enable the farmer in the grain-growing districts in the west to make on his own farm fuel for running his machinery and light for his buildings. It is not expected to compete outside these districts with other fuel. According to the *Journal of Commerce* of October 5, a company has been formed in North Dakota to manufacture and install plants for straw gas.

THE SURVEYORS' INSTITUTION.—It has been decided in connection with the Surveyors' Institution to form county branches for the Metropolitan area. Such branches have been working for some time in the provinces, and the success which has attended these organisations has encouraged the council to extend the idea to London. It is hoped that this will enable a larger number of the members to take an active part in its work, and that it will be easier to obtain the opinion of London members on matters of public or professional interest. Three branches are at present proposed, viz., the north-western, the south-western and the eastern branches. As the membership roll now stands, each of these divisions would have about 400 members. Inaugural meetings of these branches will be held at the Institution on December 7, 8 and 9, at 4.45 p.m., for the branches named, in the order above. At these meetings the methods of organisation will be explained and the necessary officers will be elected. Nominations may be sent in to the secretary.

THE KINGSBURY LIGHT CAR.

CONSTRUCTED BY THE KINGSBURY ENGINEERING COMPANY, LIMITED, ENGINEERS, LONDON.

Fig. 1.

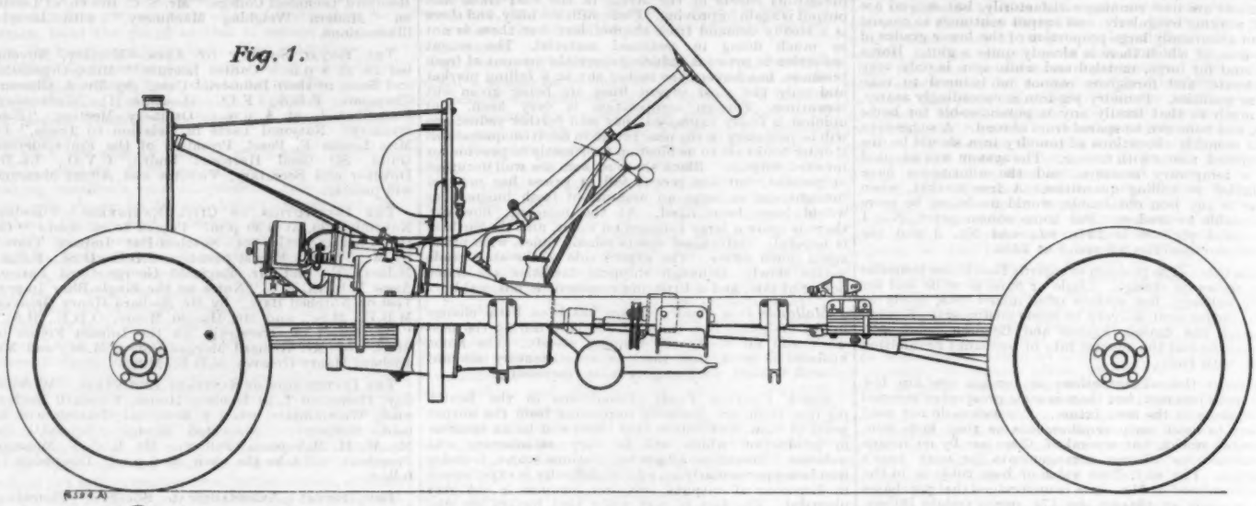
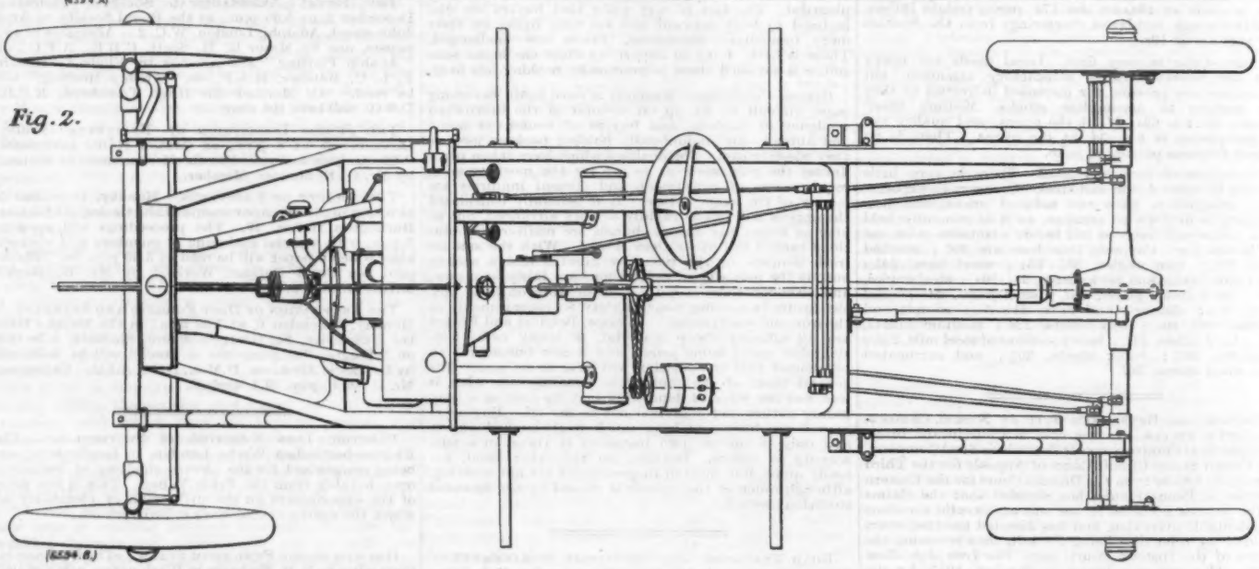


Fig. 2.

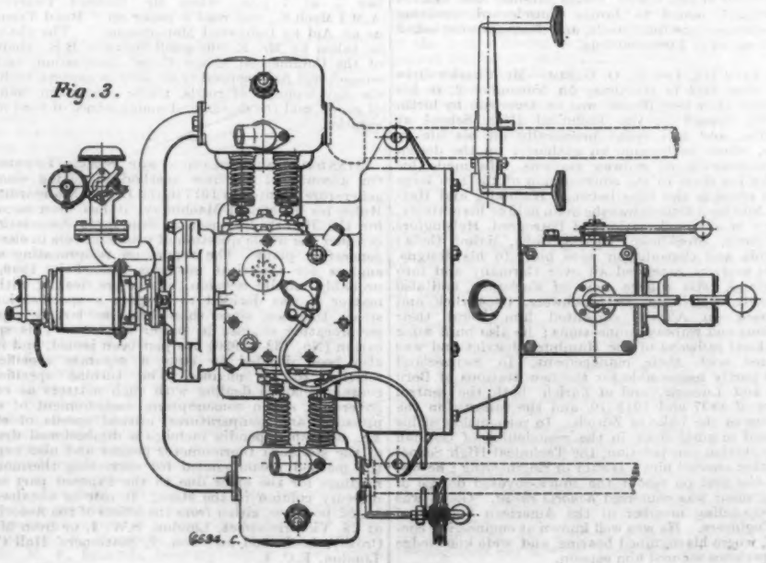


A NEW light car of promising design is the Kingsbury, shown by the Kingsbury Engineering Company, Limited, London, N.W. 9. We illustrate it in Figs. 1 to 3 above, of which the first two give respectively the elevation and plan of the chassis, while Fig. 3 is a plan of the engine and clutch unit. This car has a horizontal two-cylinder opposed engine, with cylinders 85 mm. by 90 mm. stroke (approximately 3⅓ in. by 3½ in.). The cylinders are separate castings and are of the L-head type, the valves being placed on the upper side. Ball bearings are used for the main bearings of the crankshaft, plain bearings of ordinary type for the big ends. Lubrication is by pump circulation. A cone clutch transmits the power to a three-speed gear-box of the usual type. The change-speed lever is mounted centrally on the gear-box.

The engine and gear-box are all bolted up in one unit, which is carried on a three-point suspension in a manner similar to many American cars. The frame is of simple construction, consisting of two longitudinals and three cross-members, and has at each end long quarter-elliptical springs carrying the front and back axles. The latter is of the usual bevel type, the standard gear ratio being 4½ to 1. Both brakes are internal expanding on the back hubs. The steering is by bevel gear and quadrant in place of the usual worm and wheel.

The tyres are 700 mm. by 80 mm., and the weight of the car complete with two-seated body is 800 lb., or about 7¼ cwt. Electric light is provided but not a self-starter, as this is not considered necessary in a light, cheap car. The whole chassis looks light and well-designed, and should be simple both in the machining and erecting.

Fig. 3.

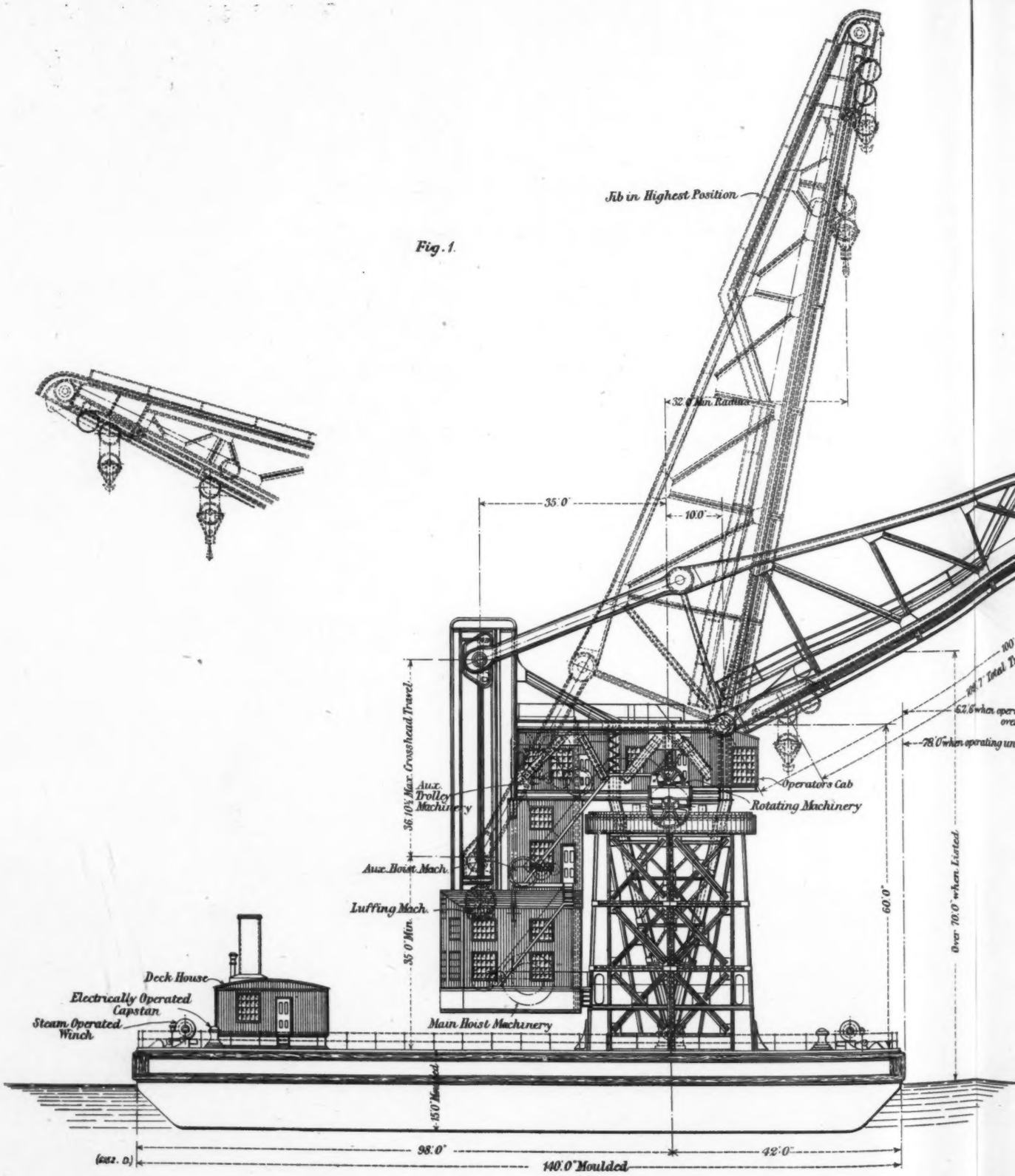


150-TON FLOATING CRANE FOR TH

CONSTRUCTED BY THE WELLMAN-SEAVER-MORGAN COMPAN

(For Description, see Page

Fig. 1.



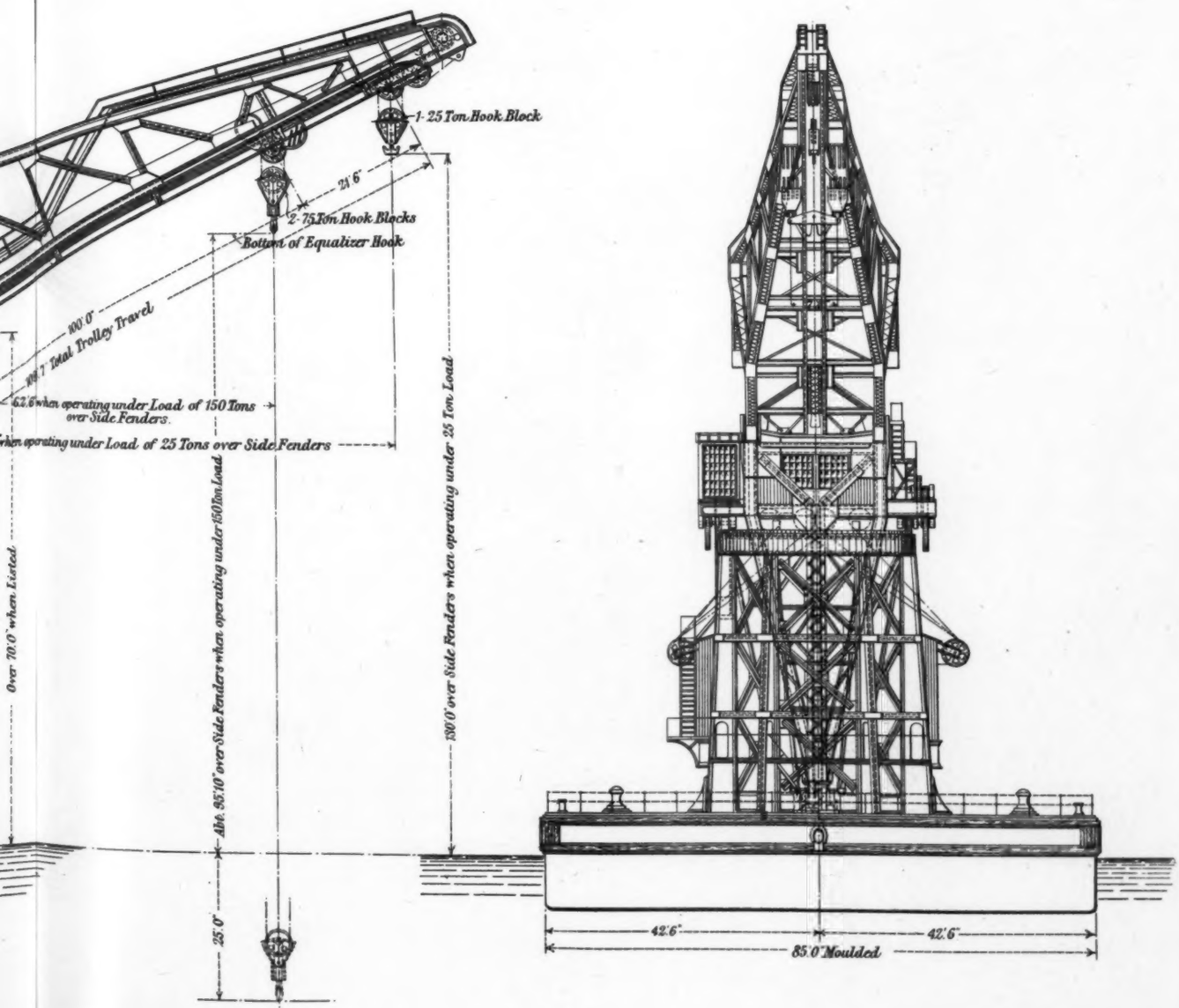
FOR THE UNITED STATES NAVY.

ORGAN COMPANY, ENGINEERS, CLEVELAND, OHIO, U.S.A.

(For Description, see Page 704.)

Ft. 0 2 4 6 8 10 20 30 40 50 100 Feet

Fig. 2.


1-25 Ton Hook Block
21'6"
2-75 Ton Hook Blocks
Bottom of Equalizer Hook
100'0"
108'7" Total Trolley Travel
62'6" when operating under Load of 150 Tons over Side Fenders.
when operating under Load of 25 Tons over Side Fenders
Over 70'0" when Lifted
Abt. 85'10" over Side Fenders when operating under 150 ton Load.
25'0"
150'0" over Side Fenders when operating under 25 Ton Load.
42'6"
42'6"
85'0" Moulded

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Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

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Thin paper copies	£3 3 0
Thick ,, ,,	£3 7 6

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With a Two-Page Plate of a 150-*TON FLOATING CRANE FOR THE UNITED STATES NAVY.*

NOTICE.

A few months ago the Proprietors of "ENGINEERING" were compelled to advance the price of this Journal to 1s. per copy, owing to the enormous increases in the cost of paper, engravings and printing, &c. Now higher transport and delivery charges involve a further increase to 1s. 2d. per copy, and this price dated from and included the issue of Friday, April 2, 1920. As the postal rates have been again increased, the price of single copies sent by inland post is now 1s. 2½d.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions still imposed by the Government on the importation of paper and the consequent shortage of supplies, Newsagents will not have copies for chance customers; therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 707.

ENGINEERING.

FRIDAY, NOVEMBER 26, 1920.

ELECTRICAL PROGRESS.

THE best criterion from which to judge the advance of electrical science and practice in the last fifty years lies in the very remarkable way in which electrical methods and electrical apparatus have penetrated into almost every branch of human activity. This is probably true of mental as of material affairs, but referring more particularly to the latter it is more than doubtful if any other branch of science can show similar universality of application. It is true that mechanical engineering covers a wider field, if one dignifies every mechanical appliance by regarding it as an example of mechanical engineering, but to do this would hardly be more fair than to bring the thunderstorm within the curriculum of electrical engineering. The man of the stone age had some rudimental mechanical knowledge, but one can hardly claim him as a mechanical engineer.

In actual definite application the range of electrical methods is remarkable, and few of the great material advances of recent years but have been beholden to the work of Faraday and Maxwell. Even the great triumphs of mechanical engineering, the development of the internal-combustion engine and the aeroplane, could hardly have been possible without the great developments in electrical machinery which have followed the fundamental work carried out at the Royal Institution. In power distribution, transport, metallurgy, process work of all kinds, artificial lighting, shipping, flight, printing and its own peculiar sphere of news transmission, electricity has established a position which at the founding of the Institution of Electrical Engineers in 1871 would have appeared impossible of attainment at any time; much more would it have appeared impossible in less than half a century.

The Institution of Electrical Engineers was founded as the Society of Telegraph Engineers in May, 1871, the year we have just mentioned, so that its jubilee is due to fall in a few months from now. In virtue of this occasion it was fitting that Mr. Llewelyn B. Atkinson, the new president of the Institution, should devote a considerable part of his address, which was delivered on the 18th inst., to a review of the electrical progress with which the life of the Institution has been contemporaneous. Mr. Atkinson divided his address into a number of sections dealing each with one of the branches of that advance, such as "physical and electrical science," "electric cables," "telephony," and so on. Four further sections towards the end of the address dealt with problems needing study and solution. Some of these problems were scientific and concerned electricity in agriculture and the transmission of vision by electrical means. Some were industrial, or sociological, and concerned the changing bases of productive industry and the application of the scientific method in commerce.

In all, the address was divided into 15 sections, including the introduction and conclusion. We have many times thought that presidents of our various scientific and technical institutions frequently make the mistake in their inaugural addresses of attempting to deal with too many things. One can call to mind more than one instance in which an admirable address would suddenly break off and proceed to a new subject which was in no sense complementary to the former, but which formed what was in effect a separate address. This kind of thing is a grave mistake, and a kaleidoscopic and disconnected variety may well be left to the picture theatres. We consider, however, Mr. Atkinson is not to be charged with this type of presidential weakness. His address had an essential unity, and it was rather the breadth of the field with which it fell to him to deal than any discontinuity of subject that led to its large number of sections. All of these sections were admirable, and many of them might with no flattery be described as masterpieces of exposition. Nonethe-less, in view of their number and the concentrated matter which each contained, it must be confessed that to listen carefully to the reading of the address was somewhat of an effort. Is it permissible to say that the effect was somewhat like reading through the "Home University Library" at a sitting?

An important milestone in the history of the Institution of Electrical Engineers is to be passed during Mr. Atkinson's year of office and his address forms a very worthy summary of the progress from the beginnings to that point. Its concentration and extent are compatible with the dignity and importance of its subject, and in the greater leisure of the study or the reading room the address is likely for many years to act as a work of reference and inspiration. In attempting any review of the address in the limited space of a short leader one's difficulty is purely one of selection. There is so much worthy of comment and praise that it is not easy to decide what must be left out. The address bristles with subjects and, in addition to its other qualities, we are almost inclined to describe it as the electrical leader-writer's *vade-mecum*.

It would be interesting and valuable to follow, under Mr. Atkinson's guidance the development of electrical and physical science from the days of Faraday to those of Einstein. In view of its compass this survey is remarkable and Mr. Atkinson concludes it by the feat of leading up to and referring to the theory of relativity in such a way that the plain man may understand what he is talking about. Again, we might follow Mr. Atkinson in his review of the progress of the generation of electric currents by mechanical power, his story of the development of electric cable engineering, or his *résumé* of the history of telephony or telegraphy. As we have said, it is difficult to know what to select and what to omit, but in view of its intrinsic interest and to some extent to its novelty of presentation we propose to deal in a little greater detail than is possible with the major part of the address with Mr. Atkinson's survey of the problem of electricity in agriculture.

To the best of our knowledge much the greatest amount of work in connection with attempts to improve or hasten plant growth by electrical means has been confined to the running of charged wires above the fields, or plots, containing the plants. Some experimenters no doubt claim that this method is a proved success, but in general, and as a matter of scientific evidence, we do not think that anything is yet proved, one way or the other. As Mr. Atkinson points out, work of this kind cannot hope to be of value unless directed by a skilled horticulturist, who at the same time must understand electrical phenomena. The pure physicist who carries out experiments of this nature is quite likely to be entirely misled by extraneous effects having no connection with the electrical side of the matter at all. The rate and quality of the growth of plants is, for instance, enormously affected by the history of the land on which they are grown, and as examples Mr. Atkinson quoted the case of a field in which a dressing of chalk on part of the area affected the crops in that part for twenty years after, and another in which the effect of the ploughing in of snow on part of a plot affected the crops on that area for years.

Other factors such as time of sowing, and weather, the detailed effects of which are little understood,

also have much bearing on plant growth, and Mr. Atkinson referred to a field of his own which this year was sown with barley, and over that was sown for an after crop of clover. Owing to rains there was a difference of 10 days in the sowing of the clover on different parts of the field, and the result was a good crop for the later sowing and a bad one for the earlier. A somewhat similar result was obtained in a field of swedes. The reason for discordant results of this kind cannot be scientifically stated by horticulturists or any one else, and it is impossible not to agree entirely with Mr. Atkinson when he says that the way to tackle the problem of stimulating growth electrically is by means of pot experiments in which the various extraneous factors may be at least to some extent controlled.

There is, after all, something singularly crude in slinging some wires over a potato field and charging them electrically. The same remark applies to the Wohler process of so-called electrification of seeds. This consists in placing them in a solution of common salt and passing a current through the solution, afterwards drying the seeds before sowing. These things may do some good, but after all it would not require much ingenuity to devise other ways in which plants or seeds might be brought within the sphere of action of electrical phenomena. The whole of this question appears at present to be on a most unscientific basis and the obvious way to deal with it is by a series of pot experiments, which would unquestionably be long and complicated, but which might result in the beginnings of an idea of what we are trying to do.

Electrical engineering is an art which, in general, shows a closer correspondence between theory and practice than any other. The phenomena with which it deals have to a large extent yielded to mathematical analysis, and we think it correct to say that as a result many of the devices for its application, show an efficiency which is not approached by other types of machinery. This state of affairs is, however, far from being approached in the sphere of electro-culture, the experimental basis of which is probably less scientific now than was that of the earliest developers of the steam engine. If Mr. Atkinson's survey of the subject does something towards the inauguration of a reasoned and co-ordinated series of experiments it will have done much to help forward a very important subject.

The possibilities which lie in the practical application of a science the phenomena of which have been properly investigated and codified are probably better exemplified in much electrical work than anywhere else, and the results in these spheres should act as an incentive and a hope in the investigation of the effect of electricity on plants. This aspect of electrical work as illustrating the amazing possible practical results of pure science should by the way form an interesting and useful subject for discussion. To what extent the efficiency of many electrical machines compared with that of prime movers is to be attributed to the rigid mathematical foundation of their design is a matter worthy of careful investigation. We present the subject to some future president of the Institution of Electrical Engineers.

THE PROBLEM OF THE HELICOPTER.

The fact that inventors since the days of Leonardo da Vinci have applied themselves to the problem of the helicopter without producing results of any practical utility is not of itself complete evidence that the problem is incapable of solution. It may, however, be taken as an indication that the difficulties to be overcome are by no means inconsiderable. These difficulties lie not only in obtaining the necessary vertical force to raise and sustain the machine, but also in providing for horizontal movement, and stability and control in flight, and in ensuring a safe descent in the event of engine failure. All these are essential features of any flying machine and, for the machine to be a practical success, it must be able to carry a certain amount of useful load in addition to its own weight, and to do this without too much complication and with a reasonable expenditure of fuel.

All these characteristics are possessed to a more or less satisfactory degree by the modern aeroplane, to which the principles of soaring flight have been successfully applied, but it is a matter of common knowledge that the aeroplane falls short of the helicopter, or direct-lift machine, in one or two particulars. The helicopter could rise from, or alight on, the ground, or a ship, in a space but little exceeding its own dimensions, and it could also hover stationary in the air. These features would enable it to start from and return to small aerodromes in the centres of large towns and would also probably have some advantages in connection with bombing and other military and naval duties, though these advantages would be shared, to some extent, with aircraft of the lighter-than-air type. In any case it is important to consider at what cost the advantages mentioned would be gained, and we are led to do so after listening to a paper read last week before the Royal Aeronautical Society by M. Louis Damblanc, who, is investigating the subject of helicopters under the auspices of the French Government. M. Damblanc does not regard the helicopter as a competitor of the aeroplane, but considers that one is the complement of the other and that both types will have equal importance in aviation of the future. Prophesies are always dangerous, particularly in aeronautical matters, but there are certain fundamental difficulties in connection with the design of helicopters that lead us to the conclusion that if a successful machine of this type is ever produced its applications will be extremely limited.

The principles underlying the design of helicopters were, we believe, first enunciated by Colonel Charles Renard in 1903, who showed that in a lifting airscrew the thrust varies as $n^2 D^4$ and the power absorbed as $n^3 D^5$, where n and D are, respectively, the revolutions in unit time and the diameter of the airscrew. From these relationships it follows that the thrust per unit horse-power is inversely proportional to the product n D, and since, for similar airscrews, this product diminishes as D is increased, the thrust, or lifting power, for any given horse-power applied can be increased indefinitely by merely increasing the diameter of the screw. Actually, of course, a practical limit to the increase in diameter is set by the weight of the screw itself, which, for similar construction, increases as the cube of the diameter, but the theoretical consideration outlined above indicates that a large screw rotating comparatively slowly will give the best results in a helicopter. In any practical machine it is necessary to employ two screws rotating in opposite directions so that there will be no resultant torque tending to cause the machine itself to rotate. As a result of these, and other, considerations, M. Damblanc has arrived at the conclusion that the optimum diameter for a lifting airscrew is 7 m. (23 ft.), and has designed and partially constructed a machine having two such screws (each having four blades) carried by outriggers on a fuselage similar to that of an ordinary aeroplane, and having a landing chassis, tail plane and tail skid. From model experiments he has deduced that the screws, when running at 160 r.p.m., will each absorb 115 h.p. and give a direct lift of 700 kg. (1,543 lb.), and as the weight of the complete machine is only 1,200 kg. (2,645 lb.) the lift will exceed the weight of the machine by 200 kg. (441 lb.).

To give the machine a horizontal velocity it is proposed to incline the axis of the airscrews by about 10 deg. to the vertical, so as to produce a horizontal component of 250 kg. (551 lb.) which, it is anticipated, will give a speed of 140 km. (87 miles) per hour; no mention, however, is made of the effect of this horizontal velocity on the action of the screws. The means to be adopted to ensure longitudinal and lateral stability, the latter being apparently a particularly difficult problem, are not dealt with in the paper, but it is explained that, in order to reduce the downward velocity to a safe value in the event of engine failure, the screws will be de-clutched from the engines, have the angles of attack of the blades reversed, and be allowed to rotate freely in the normal direction. We are not sufficiently familiar with the driving gear and other mechanical details to express an opinion as to the efficacy of this part of the scheme, but the practical arrangements will obviously call for considerable ingenuity and skill in design. In fact, the various parts of the problem referred to in this paragraph so bristle with doubts and difficulties that personal courage is not the least important characteristic required to overcome them.

On the matter of direct lift, however, we are on surer ground. Helicopters have already been constructed which lifted their own weight, and we are not disposed to dispute the possibility of obtaining the lift calculated above. If all the other difficulties we have briefly referred to are satisfactorily dealt with, M. Damblanc's machine will lift a total load of 3,086 lb., of which only 441 lb. is useful load, and convey it at 87 m.p.h. for an expenditure of 230 h.p. On the other hand, one of the aeroplanes of the usual type selected at random from among those exhibited at Olympia this summer, will, for about the same horse-power, transport a rather greater total weight at 115 m.p.h. and, of the total load, 1,220 lb. is useful. There can be no argument as to which machine would be preferred for commercial aviation, even making allowance for the valuable starting and alighting properties of the helicopter. No one could contemplate such a sacrifice in performance to secure this one desirable feature so that we are left with military and naval uses as the only possible field of employment for the helicopter when this has proved itself to be a really safe and reliable machine.

In conclusion we would point to the fact that both the helicopter and the aeroplane derive their sustentation dynamically by imparting downward momentum to the air, and the engine has to produce this momentum in both cases. In the former, however, the lifting effect is derived from the movement of a comparatively small volume of air at a fairly high velocity by means of the screws, while in the latter it arises from the movement of a larger volume at a lower velocity by means of the wings. Less energy is required to move the air in the second case than in the first, and hence the higher efficiency of the aeroplane as compared with the helicopter. The aeroplane is the same in effect as a very large airscrew blade rotating in a path of infinite radius, and it hardly seems possible to obtain the same result from a helicopter of practical dimensions. The sacrifice of efficiency merely to obtain better landing properties is, we think, a step which it is difficult to justify, particularly as considerably lower landing speeds may be obtained with ordinary aeroplanes in the not-far-distant future without any loss of efficiency, by employing special forms of wing.

ELECTROPLATING.

Galvanoplastic art was for long periods classed as an applied science, with little more justification, however, than were many other technical processes. Jacobi at Dorpat and Spencer at Liverpool are said to have independently and accidently observed in 1837 that the electric current deposited metallic copper from its sulphate. Jacobi communicated his experiments to the Academy of St. Petersburg, and that city, Birmingham (Messrs. Elkington), and Paris (Christofle) soon became centres of a small electroplating industry. The use of cyanide solution for silver baths, discovered by Wright in 1840, was adopted by Messrs. Elkington. Yet, though Smee wrote on the "Elements of Electrometallurgy" in 1843, and though Gore, author of the "Art of Electrometallurgy," of 1877, was the chief adviser to Messrs. Elkington, Mr. W. R. Barclay, speaking at Sheffield last Friday dated the systematic scientific study of the electrolytic deposition of metals only from this century and connected it notably with the researches of Brunner and Foerster, published in 1907.

The occasion of Mr. Barclay's remark just mentioned was a general discussion on "Electroplating," arranged by the Sheffield Section of the Faraday Society and the Institute of Metals, and held very appropriately in the Mappin Hall of the Department of Applied Science of Sheffield University, which thus identifies itself with another of the leading industries of Sheffield, as it has long been identified with the Sheffield metallurgy of iron. The discussion occupied both the afternoon and evening. The meeting was formally opened by Sir Robert Hadfield, as President of the Faraday Society; Professor C. H. Desch presided over the afternoon session, and Mr. E. A. Smith over

the evening session, which was particularly devoted to silver plating. We will first deal with the latter subject, one very important for Sheffield.

The electro-chemist ought to be able to explain why modern silverplating is not superior to old plating. In most electrochemical processes purity of the reagents is a prominent condition. Our modern chemicals are certainly purer on average than chemicals were sixty years ago, when Sheffield began to electroplate. Yet, oddly enough, silver baths fifty years old are generally credited to give better results than freshly-prepared baths or baths only a few years old. Mr. Barclay stated in his paper on "Electro Silver-Plating and its Technical Development" that he had examined and studied for three years a large number of silver vats from different plants, working under different conditions, and had found that the old vats yielded superior deposits. The question of appearance, *i.e.*, taste, which changes with fashion, may come in there, and that question was not discussed. But it is rather startling to learn that the same vats have been used for forty years and more, and one wonders how the dust is kept out when the cyanides of silver and potassium are replenished. That solutions in regular use answer better than solutions in intermittent use, is clearly connected with the composition of the bath.

Chemists well know that the poisonous potassium cyanide gradually changes into the harmless potassium carbonate. But organic compounds and ammonium salts also appear in the baths, coming possibly from the dust and atmosphere, and sodium chloride may also get into the solution with the dust. As the same baths are used for years, all these bodies, notably the carbonate, accumulate in the solution and increase its electric conductivity. That may partly account for the advantages of old baths. But the reactions are not fully understood. As regards the ratio of "free" cyanide (KCN) to bound cyanide in the soluble double salt $K.Ag(CN)_2$, Mr. Barclay accepted Brunner's ratio of 2 : 1. Other potassium salts, including the carbonate and the chloride, are added to raise the conductivity, and Fary and Porter indeed consider the specific gravity of the solution to be a rough measure of its conductivity.

According to Mr. Barclay the bath should be worked at temperatures between 17 deg. and 23 deg. C., and at a current density of 2¾ or 3 amperes per square foot. Mr. Frank Mason, in his paper on "A New Maximum Density in Commercial Silver-Plating," suggested, on the strength of researches conducted at Sheffield University, the use of current densities of 8 amperes, more than twice the usual practice, and in order to make working at such high rates possible to add quite unusual amounts of potassium carbonate to the bath. His solution contains, *e.g.*, 26 grammes of silver, 47 grammes of KCN and 165 grammes of potassium carbonate. Mr. A. Bowker and most of the practical platers and scientists present strongly deprecated this suggestion of doubling the output by doubling the current density; Dr. W. Price alone stood up for Mr. Mason, whose observations he fully confirmed. Mr. G. Bernard Brook, F.I.C., who together with Mr. L. W. Holmes contributed a paper on "The Chemical Composition of Old Silver-Plating Solutions," did not support the high current density either. His detailed account of the examination of 61 solutions up to forty-nine years old, from firms and private sources, is valuable. He has studied composition, specific gravity, working conditions, appearance of deposit, conductivity, &c. He finds, in agreement with others, that most of the conditions may be varied within wide limits; the conductivity is one of these variable conditions, depending, he thinks, mainly on the potassium carbonate percentage; the silver contents of the bath may also be varied without detriment, but the use of a large excess of free potassium cyanide he considers superfluous and uneconomical.

Another paper read at the meeting, namely, that by Mr. Brook, on "The Crystalline Structure of Electro-Deposited Silver," was more controversial. Of late, silver-platers have been troubled with a patchy, cloudy appearance of their burnished silver, the patches looking reddish when rouge is used for polishing. The trouble seemed to occur mainly during hot summers. On investigating the possible causes, the burnishing, scratch-brushing, deposition, &c., Mr. Brook came to the conclusion that, especially at high current densities, the deposit became acicular instead of grainy, fine silver needles sticking up which the burnishing had to bend over and to flatten down. These needles can be seen on the edges of dishes.

Passing to the afternoon meeting and to "Electroplating for the Prevention of Corrosion," the title of a communication by Mr. Leslie Aitchison, D.Met., B.Sc., we would like to express our regret that the term "galvanised iron" should still be used in speaking of iron coated by being dipped into molten zinc. That process has nothing to do with electrodeposition by what was originally called galvanic currents. Electroplating in the cold, or at any rate from merely warm solutions, has many advantages over hot dipping, but has not yet developed to the same extent. The popularity of the nickel-plating of cycles, &c., is largely due to the improvement in appearance. But electrolytic zinc deposits, Dr. Aitchison pointed out, are more uniform and may be much thinner and lighter in weight than coatings of tin—perhaps too strong a statement, we shall see. Aircraft steel must not be dipped hot, because the heat would destroy the previous treatment by cold-work or tempering applied to impart a special strength or hardness to the material. In such cases we are restricted to electrolytic deposits, but they must possess one additional property, not generally essential to electroplating, that is ductility. The article may have to be shaped after plating, and should hence always be submitted to bending tests. With respect to rust protection, Dr. Aitchison referred to one theoretically somewhat obscure point. We protect iron against rusting by covering it with zinc, which is electropositive to iron, or with copper, which is electronegative. As long as the metal coating is perfect, the nature of the metal does not matter. When the coating is locally damaged, copper-coated iron rusts more rapidly than zinc-covered iron; but the latter rusts also, apparently as much as if the zinc were absent. In cleaning the iron to be coated Dr. Aitchison would prefer sand-blasting, if applicable, or anodic cleaning to ordinary acid pickling.

Though Mr. W. A. Thain (late Captain R.A.F.) confined himself in his paper on "Electroplating in Aeronautical Engineering," to copper deposition and to three types of processes, his communication was of considerable interest. He first dealt with copper deposition for the purpose of preventing local carburisation. Certain parts of camshafts valve-gear rocking levers, &c., have to be case-hardened, whilst the remaining portion must be left soft and ductile. In such cases, parts unnecessarily carburised on the surface may be machined off, or the parts not to be hardened can be covered with a protective coating impervious to carbon. Copper has best answered for this latter purpose. To exemplify this, Mr. Thain exhibited a slide of a piece of iron which was first coated with copper; iron had then been deposited on the top of the copper, and the whole piece been case-hardened; the external iron layer was distinctly carburised, but no carbon had penetrated through the copper to the iron core. Other slides and analyses demonstrated the protection of camshafts rocking levers and adjusting screws of valve push rods. The specimens require very careful treatment, however: thorough cleaning, brushing with caustic soda, varnishing of the parts not to be protected with a mixture of yellow chrome and copal at 160 deg. C., and immersion in the first instance for 5 minutes in a bath of copper cyanide at 16 deg. C. to produce an initial well adhering film of copper. This film is then thickened in acid copper sulphate (34 oz. to 8 oz. of sulphuric acid in 1 gallon of water), and the use of anodes of pure copper. Instead of varnishing the special parts, the whole may be plated, and the copper afterwards rubbed off with emery where not required.

Certain parts are also plated to improve their thermal conductivity. This treatment applies mainly to fins of radial engines, where the deposit should have maximum thickness at the root of the fin, diminishing in thickness to the point. Such deposits can be obtained by the aid of specially distributed anodes, circulation of the electrolyte, rotation of the piece and deposition at low current density for 60 hours and more; but it is debatable whether the advantages gained warrant the additional work and expense.

The third process, that of building up constructive detail, was exemplified by the case of the water jackets of Beardmore aero-engine cylinders. The cylinders are made of cast-iron, and the copper jackets, which have been made by hundreds, admit of a considerable saving in weight; but again the process is not simple and demands care and skill. The cylinder is rough bored, the skirt turned, and the cylinder tested for strength at 450 lb. per square inch; the thread at the skirt for the steel flange is cut, and the cylinder is secured to the crank-case and sweated on. To prepare the tapered thread on the skirt and the flange, they are covered with a film of copper from a cyanide bath, for 10 minutes, in order to ensure good adhesion of the solder in the sweating-on. The flange is then machined up and is put inside an iron mould, which has the shape of the inside of the jacket. A low-fusion alloy is cast round the cylinder, the outside of the setting alloy corresponding with the inside of the jacket; the alloy is either Wood's metal (lead, bismuth, tin, cadmium in proportions 25 : 50 : 12·5 : 12·5) or a special low-fusion alloy of tin, bismuth, cadmium in proportions 1 : 1 : 1. The mould is removed and the whole cylinder scoured with pumice powder and thoroughly cleaned; the inside of the cylinder is coated with paraffin, stoppers being placed in the ports; the flanges are covered with beeswax, and the whole cylinder is suspended and rotated at 30 r.p.m. in the cyanide bath (4 oz. of potassium cyanide and 8 oz. of copper sulphate to 1 gallon of water, also some sulphuric acid). A cylinder requires currents of 20 amperes at 1 volt or 2 volts for 80 hours to produce a copper deposit 1·5 mm. thick weighing 3·5 lb. After the deposition of this first coat the alloy is melted out in oil or hot water; the cylinder is cleaned again, and a second coat of copper is applied in 10 hours, the thickness of the jacket being increased to 1·7 mm. The jacket is finally tested at a hydraulic pressure of 25 lb. or 30 lb. per square inch.

We can only briefly mention two other papers, one by Mr. W. E. Hughes, on "The Use of Colloids in the Electrodeposition of Metals," a subject much written on, but not clear yet, and the other by Mr. Byron Carr, on "The Electrodeposition of Cobalt." Protective cobalt coatings for iron and for mirrors have long been advocated, and in Canada especially the problems have been studied by Kalmus and his collaborators in order to find uses for the cobalt from Canadian mines. Mr. Carr recommends a bath containing 4½ lb. of cobalt sulphate, 5½ oz. of boric acid, and 2½ oz. of sodium chloride per gallon of water at 34 deg. C., deposited at current densities of 150 amperes or 72 amperes per square foot for periods not exceeding 2 minutes or 4 minutes respectively. The thin deposits were described as exceedingly hard and resistent in general, but apt to be attacked by fruit juices. We hope to revert to this paper contributed by Mr. Carr; Dr. Desch and other speakers drew attention to the importance of his prolonged researches.

WOMEN AND THE TWO-SHIFT SYSTEM.

EMPLOYERS engaged in the lighter branches of engineering will be interested in the favourable report on this subject by the Home Office Committee which was appointed in August last "to consider whether it is desirable that the Factory and Workshop Acts should be so amended as to allow women and young persons to be employed on the system of two day shifts." Prior to the war the employment of women and young persons on the two-shift system was impracticable under the Factory and Workshop Act, 1901, which requires (1) that in each factory and workshop employing women and young persons there shall be fixed a daily period of employment within the limits 6 a.m. to 6 p.m., 7 a.m. to 7 p.m., or, in the case of non-textile works, 8 a.m. to 8 p.m., and (2) that the hours of work shall be the same for all women and young persons employed.

During the war it became necessary for these

restrictions to be relaxed, and this was done, by means of Home Office Orders issued under powers given by the Defence of the Realm Regulations. As a result women and young persons were employed on the shift system in a large variety of trades, and that has continued since the armistice. The approaching expiry of the Defence of the Realm Regulations raised the question whether it was not desirable that the Factory Act should be amended so that the system might be continued. The Home Office realised that if this were not done a large number of women would be thrown out of employment, and it was thought desirable that the system should be allowed to continue, and that the Factory Act should be amended accordingly. The Government proposed to do this by means of a clause in the Women, Young Persons and Children (Employment) Bill which was introduced into the House of Commons early this year as a result of the Washington Conventions; but the clause met with so much opposition on the second reading that the Home Office had to undertake to appoint a committee to inquire into the whole question. The clause was subsequently rejected in Standing Committee of the House of Commons, but the Home Office Committee proceeded to hear evidence, and the report above referred to is the result of its labours.

The evidence showed the advantage of the system in the case of continuous processes, seasonal trades and factories where there is a temporary shortage of premises and plant; and employers, including representatives of the engineering industry, gave evidence in favour of it as a regular part of their industrial system in order to secure increased output, especially in view of the shortening of hours and the increased cost of raw material and plant. The medical evidence was not adverse to the system, and although certain objections were urged against it by "persons interested in women's work and welfare," it did not appear that the workers themselves had any general preference for or against it. The report states: "Many expressed a preference for work on a single day shift, but were afraid lest a return to a single shift might throw them out of work. Many others expressed a strong preference for the two shifts. The reasons for these opinions vary very much. Some like one thing, and some another. . . . Taking the evidence as a whole we can arrive at no general statement of the opinions held by those women who are employed on the system."

After carefully considering the evidence the committee have come to the conclusion that although the experience of the system is limited and the whole matter is meantime only in the experimental stage, yet the system should be allowed, under proper conditions, in continuous processes, seasonal trades and factories where the plant and premises are temporarily insufficient, and that, subject to proper safeguards and supervision, an opportunity for trying the system should be given to those who desire to introduce it as a regular part of their industrial system for the purpose of increasing production. They also consider that the system might be sanctioned for, say, five years, at the end of which period the whole situation could be reviewed by Parliament, but that meantime the adoption of the system should be dependent on the issue of Home Office Orders. The following are among the recommendations of the committee:—

"1. The Secretary of State should be given power to make Orders allowing the employment of women and young persons of 16 years of age and over on a system of two day-shifts of not more than 8 hours' average duration between the hours of 6 a.m. and 10 p.m. from Monday to Friday, and 6 a.m. and 2 p.m. on Saturday. These Orders should we think, be granted for individual factories, or for a class or group of factories, subject to such conditions as the Secretary of State may consider necessary to safeguard the welfare and interests of the workers. The Orders should be expressed to be liable to withdrawal in the event of non-compliance with the conditions or of any abuse arising but subject to this should be regarded as intended to be effective for the period hereinafter mentioned.

"2. The power to make Orders should not extend to young persons under 16 years of age, but we are of the opinion that an exception should be allowed, for those young persons under 16 who are at the present time employed on the shift system, so long as they remain in their present employment.

"3. The power to make the Orders should be given for a limited period of five years in the first instance, and at the end of, say, four years, inquiry should be made into the whole question in the light of the additional experience gained."

It is to be hoped that the Government will endeavour to give legislative effect to these very reasonable recommendations.

NOTES.

Iron Conductors for Overhead Networks.

In a note published in a recent issue of the *Annales des Travaux Publics de Belgique*, M. C. Lemaire describes how Germany managed during the war to make large extensions to her network for electric power distribution, although, setting out from 1916, the use of copper was prohibited for any but military objects. For overhead conductors bare wires or cables of iron were used. When the section needed was greater than could be provided by a wire 6 mm. in diameter, cables were employed, as it was found that wires of larger diameter than the above limit were too stiff to be conveniently handled. Before fixing, it was found advisable that the wire or cable should be straightened, as otherwise there was likely to be trouble with kinks. Great care was found necessary to avoid damaging the galvanised surfaces of the main wire and of the bindings, since otherwise deterioration from rust was rapid. Special care was also necessary in making soldered joints and to protect these from rust the surfaces were washed with lime water and tarred. In the case of high-tension installations it was found that iron wires fused more easily than copper, and it was therefore found advisable to place lightning arresters on each post. In making junctions between iron and copper conductors it proved necessary to protect the joint from all access of moisture. The cost of the iron network was generally considerably more than if copper had been used owing to the larger section required and the greater cost of handling. In the case of lines conveying continuous current the cost was 20 per cent. more than with copper, although the price of the latter was 4 marks per kilogramme, whilst that of the iron was only 0.71 marks per kilogramme. Where the load required such a large section of iron that two cables were necessary the cost with iron was often 50 per cent. greater than it would have been with copper conductors.

The Lake Ritom Tunnel.

In our issue of August 6 last (page 187) we mentioned that an escape of water took place from the Lake Ritom Tunnel, in Switzerland, when the turbines which the tunnel serves were put under full pressure on July 1, and that subsequently some very fine longitudinal cracks were discovered in the concrete lining of the tunnel. The committee of experts appointed by the Swiss Federal Railway Department to inquire into the accident ascribed the formation of the cracks to eight possible causes, and upon these our contemporary, the *Schweizerische Bauzeitung*, has commented in its October and November issues. The first cause suggested, shrinkage of the concrete lining and temperature fluctuations, does not appear to be of importance, since the tunnel is always damp and the temperature keeps almost constantly at 5 deg. C.; transverse cracks, moreover, were not observed. Cause 2, cavities between the rock wall and the concrete lining, seems probable, since the grouting was only introduced from the crest of the arch, and attempts made later to force grouting in near the bottom of the horseshoe tunnel section failed. The next four causes are connected with the strength of the rock. The tunnel walls were weakened by the blasting operations, more probably than would appear to the eye. The rocks may not on the whole be sufficiently elastic to bear the high internal hydrostatic pressure of the water; the rocks are not homogeneous, and the closing up of clefts was not excluded; the general steep dip of the strata would hardly lead to any considerable squeezing, but the compressibility of the rocks is to be reckoned with. The last two causes concern the concrete lining. The quality of the concrete seems to have been good, though it is regrettable that the quality tests were not carried out continuously; satisfactory tests of the materials when supplied are not sufficient in such cases. More weighty, however, is the consideration whether the concrete lining was itself of sufficient thickness and strength. Apparently the internal hydrostatic pressure was not one of the special factors in the original calculations. Considering that the grouting was probably defective, and the strength of the rock insufficient, and particularly that the tunnel section was only in some parts circular, being over the greater length of the tunnel oval, or of horseshoe shape, ample strength should have been given to the concrete lining. The hydrostatic pressure would tend to transform the oval section into a circular section. Nobody is censured by the experts, but it is admitted that as regards the effect of the internal pressure due experience was wanting, and further experiments by engineers and geologists are therefore to be made on other tunnels. In this connection, Professor K. E. Hilgard refers to the remarkable grouting operations on the Catskill Water Supply for New York, as described by J. F. Sanford and M. E. Zipser, in a paper contributed to the American Society of Civil Engineers.* In that case the pressure tunnel lies partly 1,100 ft. below the surface (in the siphon below the Hudson River), and in the City Tunnel an additional lining of thin sheet copper was used in some places where the rock was infirm. Professor Hilgard thinks that closely-woven copper or even iron wire netting might answer as well, and he insists that the pressure under which the grouting is forced in should at least be equal to the internal pressure subsequently to be reckoned with.

LITERATURE.

Waterproofing Engineering for Engineers, Architects, Builders, Roofers and Waterproofers. By Joseph Ross, B.S., C.E. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. 1919. [Price 25*s.* net.]

On every branch of constructive work, technical treatises have multiplied and experts have unloaded much information for the benefit of novices, but waterproofing has failed to attract the attention it deserves. No American University has a Professor of Waterproofing Engineering, and systematic training in this department is unknown. Mr. Ross states that six years ago, he began a diligent study of existing literature on this subject and though he found the field was large, the harvest was disappointingly small. Accordingly, in undertaking the task of collecting and systematising the information extant, he has had little guidance from predecessors, and he can break new ground unfettered by traditional methods. The road engineer utilises certain devices, the builder follows a stereotyped practice, and similarly in other branches, for all know the destructive character of water and the necessity for specific protection. But of the theory of waterproofing systems generally, and the properties and action of suitable materials under special conditions, little methodical instruction has been provided; the subject remains a sealed book, hindering the accumulation of experience and the wider adoption of improved processes. It is this gap in the literature of construction that Mr. Ross proposes to fill.

The author hazards the opinion that the growth of our civilisation may be measured by the quantity production of cement, and the commercial progress of a community gauged by the number and size of the concrete structures within its boundaries. This is a very modern view, which it is neither necessary to confirm nor to dispute, but undoubtedly concrete and steel are rapidly invading a realm long occupied by brick and stone and finding a wide application where masonry had no rival. Concurrently with the increased use of cement and

* See Engineering, April 16 and 23 and May 7, 1920, pages 525, 558 and 627.

concrete, the thorough effectiveness of waterproofing becomes pressingly urgent. Water will seep into the minutest crack and disintegration as certainly follows. Water, by its alternate freezing and thawing, exerts a considerable expansive pressure, and is the especial bane of insufficiently protected structures. If uneven settlement is to be avoided, fissures in foundation walls to be prevented, adequate waterproofing protection must be provided, and the materials capable of accomplishing the defence must be treated in a scientific manner. Hitherto, waterproofing has been regarded as a sort of necessary evil in engineering, uncertain in its action and of doubtful value against an insidious enemy. Mr. Ross is anxious that the importance of the process should be seen in a proper light.

Seepage arising from ground water and the assistance afforded for its passage by the porosity of concrete, whose structure creates a natural capillary passageway for water to enter and be absorbed in the mass, constitute the main need for an efficient type of waterproofing. These factors, ever present when concrete is employed, can be aggravated by various circumstances such as the presence of alkaline salts, of sewage, of sea water, by electrolysis, and especially by changes of temperature. Reinforcement of concrete, however efficiently placed, may delay, but does not prevent, disintegration. Its preventive action consists in diminishing the size of cracks and distributing them more evenly throughout, and in this way increasing the impermeability of the structure. But reinforcement brings a new danger by the necessity of providing expansion joints. If such joints are not provided, the resulting stresses can cause cracks and disfigurement in the building, and if present, these joints may accelerate leakage through the joints themselves. It might seem from this superficial view that, owing to the impossibility of eliminating such disturbing factors as change of temperature for example, a material that requires more or less costly protection is inherently unsuitable for building purposes. But the American Society for Testing Materials, after taking evidence and making experiments, deliberately asserts that impermeable concrete can invariably be produced. Even with sand of poor granulometric composition, if the mixture is rich, containing 1 cement, 2 sand, and 4 stone, permeable concrete is seldom found, if prepared under laboratory conditions and supervision. But practically, permeable concretes are frequently encountered, and the reasons assigned for this unsatisfactory practice, are defective workmanship, which can operate in various ways; the use of imperfectly-sized and graded aggregates; the use of excessive water in mixing; and the lack of proper provision to take care of expansion and contraction. Perhaps there was no necessity for a committee to elaborate the obvious, but the fact is emphasised strongly that since it is apparently a commercial impossibility on large construction, where speed and cost are governing features, to obtain workmanship even approximating that found in laboratory work, the most economical method for securing impermeable concrete is to adopt a special waterproofing treatment.

The importance of this remark is more particularly shown by the gradual recognition of the value of the process described here as "densified concrete" and its tendency to displace other and older methods known as "surface coating," "membrane," "mastic" and "integral." These terms practically explain themselves, but the author describes each, giving its distinctive features, its manner of preparation and of application, and the class of work on which it can be most satisfactorily employed. In the first case, for example, an impervious coating of plastic or liquid bituminous material is applied to the surface. The bituminous material is often replaced by chemical salt solutions which form insoluble salts, or the coating may take the form of a plaster coat of neat cement. The general method may be applied either during construction or after erection, is comparatively cheap and has a wide application, due in some measure to the numerous patented or proprietary compounds placed on the market. The composition of some of these is a trade secret, but many depend for their impervious capacity upon the formation of stereates of lime, which are practically insoluble in water. Of the effectiveness of these as a rule the author does not speak in flattering terms, and the American Society for testing Materials is even more outspoken. While admitting their inability to examine the whole of the great variety of materials proposed, of those tested they are prepared to say that the majority of patented and proprietary compounds tested "have little or no permanent effect on the permeability of concrete, and that some of these even have an injurious effect on the strength of mortar and concrete in which they are incorporated." The methods of application of the surface coating are various and well known, but attention may be drawn to the use of the cement gun whose operation has been much improved in the last few years, but has not obtained great vogue in this country owing to the general stoppage of building during the war. To be used with success, the materials must be properly proportioned, a leaner mixture than 1 : 3 is not to be recommended, and the sand should be somewhat moist and coarse, but graded. In operating the gun, the dry materials are forced through a hose by means of compressed air, hydrated at the nozzle, and applied with any suitable velocity. If the velocity is great, much of the sand rebounds and is wasted, but the adhering mixture is richer in cement. The combination of cement, sand and water takes place in transit, the hydration mainly on deposition; the chemical combination being effected in its final resting-place. Floating is recommended immediately after placing, to get a smoother finish, but trowelling is of questionable advantage as it may reduce the imperviousness of the mortar.

The membrane system of waterproofing is mainly applied in course of erection to those parts of the structure which are below the ground surface, as tunnels and subways. The plan involves the complete surrounding of the structure to be waterproofed by a built-up elastic continuous bituminous blanket, or membrane, composed of one or more layers of waterproofing felt cemented together with asphalt or coal-tar pitch. The membrane may, however, consist of metal, or of any material, which permits the complete envelopment of the structure to prevent the passage of water through its exterior parts. The introduction of the felt, or such material is to offer greater resistance to water pressure, and wool and jute are used for the same purpose. Shredded asbestos and other mineral fillers, combined with refined asphalt, find frequent use for increasing plasticity and the substantial character of the membrane. The preservation of the continuity of surface is of the last importance, and great care is needed lest the bituminous binder is injured by "gas drip," lubricating oil from leakage in adjacent machinery, or from sewerage.

Mastic waterproofing resembles the membrane form, inasmuch as it requires a waterproofing mixture, composed of asphalt or tar, in combination with sand, cement or stone dust to surround the structure. The applied layer may be comparatively thin, but it is used in connection with a brick-in-mastic or tile-in-mastic layer, which is much thicker than any membrane, for it is intended to resist great water pressure. The application is often difficult and exacting, but well executed, it forms the most reliable system of waterproofing, though the most expensive.

The integral system of waterproofing recognises the essentials of a good concrete but does not often attain them. Its aim is to make mortar or concrete impermeable by introducing into the mass ingredients, which act either as void fillers, as lubricants for the aggregate, or chemically upon the cement, with the object of increasing the density of the mass. As already intimated, some of these fillers are of questionable utility. The intention is to make the concrete impermeable during the process of mixing, and to eliminate the necessity for additional treatment. The criticism of the United States Bureau of Standards is very pertinent and deserving of consideration. "The addition of so-called waterproofing compounds will not compensate for lean mixtures, nor for poor materials, nor for poor workmanship in the fabrication of the concrete." Most integral compounds are small in bulk, and can have little effect in filling the voids. If the same care were taken in making concrete impermeable without the addition of waterproofing material, as is ordinarily taken when such materials are added, an impermeable concrete would be attained. That is the object attempted by rigorous scientific means in the "self-densified concrete," wherein the constituent materials are proportioned and mixed so as to create as dense a finished mass as possible, a result that is as difficult to attain as it is effective when produced. The difficulties which have to be overcome are mainly the lack of interest and inevitable fatigue of the labour employed, to which must be added the uncertainty of obtaining the specified quality and exact amount of materials for each batch, without exceptional precautionary measures.

The fact cannot be too frequently repeated or too clearly recognised, that the inherent porosity of concrete is due to the fact that only about 20 per cent. of the cement used in the making of concrete is hydrated, the remaining 80 per cent. lying in the pores, as so much inert matter, and further, the evaporation and drainage of water during the setting period implies a corresponding volume of voids in the mass. It has been suggested that many of the evils attending the use of permeable concrete could be prevented by using mixtures richer in cement. But such practice is of doubtful utility, as richer concretes are more subject to check cracking and are less constant in volume under changes of temperature and moisture.

Grouting is another system of waterproofing by which a very wet cement mortar, or neat cement, is forced, under pressure, through cracks, pipes or joints, suitably located, till refusal, or until there is evidence of the grout having filled all the seams in a rock or permeated the ground around the structure. The purpose is to force the ground water to make new channels, so that the water will not come in contact with any structure not sufficiently watertight in itself to prevent seepage.

On each of these systems the author gives a short treatise, pointing out causes of defects, insisting on correct methods of practice, and the advantages of scientific treatment. Having dealt with ground water and the foundations of structures he next takes up the methods of rendering roofs impervious, and describes the materials used and the methods of application best adapted to this purpose. Asbestos shingles and tin roofs are not much used in this country, but imperfect glass roofing is frequently encountered. The construction of watertight joints in puttyless glass roofing, though apparently expensive, is a desideratum, for to devise a joint that will remain tight under all conditions of weather and stress is a difficulty that extends beyond the roof. Wherever masonry is to be waterproofed, expansion joints have to be made in such a manner that water cannot pass through them. The waterproofing of a structure often resolves itself into waterproofing the joints, and the author accordingly examines, with the thoroughness that characterises the book, the methods used for the proper provision for expansion and contraction in concrete masonry, as well as the methods adopted for waterproofing the joints.

Two excellent chapters are given on waterproofing materials and on implements and machinery, forming an introduction to the discussion of technical and practical tests on waterproofing materials. The value of laboratory tests of such variable products as concrete, bitumen, felts and fabrics, &c., with the view of determining their physical and chemical properties, has been questioned, and a preference to rely on practical field tests is frequently shown. Some of the ill-favour attaching to laboratory tests is no doubt due to a want of appreciation of the thoroughness of the test, and of the purpose for which it is designed. Perhaps, too, there is a difficulty in interpreting the results of the test. Mr. Ross's treatise should prove illuminating on all these points. Without neglecting the information to be drawn from field tests, which may come too late to be of real service, he insists on the desirability of the engineer being acquainted with the methods of testing and his description of the processes is thorough and exhaustive. In practice, he says certain undesirable qualities may be revealed in the materials, but laboratory tests can be relied upon to reveal more. This remark is particularly applicable to the testing of the permeability of water-

proofed concrete, on which valuable results were collected after only seven days' test.

Passing over the chapter on Specifications, in which the lawyer's skill in phraseology is combined with the knowledge of the experienced engineer, and a later one on cost, data of materials, implements and labour, as being of limited application, we have two practical chapters, one containing tried recipes and special formulas, and the other on practical achievement. In the former, the author remarks on the curiously small number of basic waterproofing compounds actually in common use. Probably not more than 50 are on the market, but of special waterproofing compounds the number is legion, many of which are guarded as trade secrets, defying the skill of the chemist to determine a satisfactory analysis, and still more frequently preventing a chemical synthesis. The process of manufacturing most waterproofing compounds is more difficult and the secrecy regarding it more jealously preserved, than is the acquisition of the knowledge of the constituent ingredients. On the other hand, the United States Government Departments publish and distribute gratis many technical papers containing valuable information concerning tests on new and old methods and on the use of materials. Drawing on all known sources, Mr. Ross has been able to provide many formulas and practical recipes that have stood the test of personal experience, but even with regard to these he cautions care and judgment as essential to success. In the latter, Mr. Ross gives a number of instances in which one or other of the six systems of waterproofing already mentioned have been applied, with the methods of application and, where possible, the degree of success attained. This is important because the best criterion of the relative merits of the various materials and systems of waterproofing is their efficacy and endurance in service. Many secret and patented compounds can only be judged by their past performances and their reputation rests on their approved efficiency. It is admitted that many integral and surface coating compounds have proved their worthlessness in practice, though apparently successful in the laboratory, a fact of which the scoffers at scientific tests may make the most. An excellent treatise closes with some practical tables and a few appendices, that are worthy of careful reading. From one of these on the action of sea water on concrete, we are prevented from quoting only by considerations of space.

The Design of Screw Propellers with Special Reference to their Adaption for Aircraft. By H. C. Watts, M.B.E., B.Sc. London: Longmans, Green and Co. [Price 25*s.* net.]

As would be expected from the unique experience which Mr. Watts has had, the present book gives a sound exposition of the practice of airscrew design and construction. The explanation given by the author in the preface, that an endeavour has been made to show how an airscrew should be designed, has been fully justified. Although the book is essentially of a practical nature, it is apparent that the author has developed his practice on sound theoretical foundations. The book should therefore be of value to the theorist who does not desire to wander too far from the path of practical utility and so welcomes inspiration from the practical man. One of the outstanding merits of the work is that, when possible, the general discussions are well illustrated and amplified with detailed calculations.

The book commences with an introduction to the subject and gives definitions of the terms common to an airscrew. The chapter on aerofoils which follows is a brief *résumé* of the reports on this subject published by the Advisory Committee for Aeronautics, analysed with special consideration to the problem of airscrew design. It is, however, somewhat disturbing to read, on page 13, that the measurements of the lift and the drag of a model aerofoil are made in a wind channel at a wind speed of 40 ft. per second. Whilst such was the case in the early days of aerodynamic experiments, the wind speed, nowadays, is in the neighbourhood of 80 ft. per second, and the aerofoil has a chord length of 6 in. The chapter on the simple Drzewiecki theory is very complete and interesting. The essence of this theory, on which modern airscrew design is based, is that an airscrew blade may be considered as an aerofoil of a form suitable to glide in a helical path, the performance of the airscrew being calculated from the forces acting on elemental strips. Attention is drawn to the fact that, under ordinary conditions of working, the drag component of the force on a blade section contributes practically nothing towards the thrust, whilst the lift component has a greater effect on the torque than the drag component. In Chapter V a complete illustration of the procedure adopted in airscrew design is given, the known parameters of the design, namely, the horse-power to be absorbed and the forward and rotational speeds of the airscrew, being determined from the characteristics of the engine and the aeroplane. As usual, the camber of a blade section and the general shape of the plan form of the blade are fixed arbitrarily, the scale of the blade width being the unknown parameter of the design. When possible the author favours graphical methods of computation, which, compared with approximate algebraic formulæ, have the advantage that the designer is able to keep in closer touch with the physical aspect of the problem. The nomograph on page 75, which connects the horse-power and diameter with the forward and rotational speeds, should be of assistance in the initial stages of airscrew design. Chapter VI contains an outline of the momentum theory of R. E. Froude, and includes a description of the experimental work of Dr. Stanton, who showed that the thrust may be estimated with good accuracy from an integration, taken over the disc of the airscrew, of the difference of total head at points in two planes as close to the disc as convenient, one plane being in front of the disc and the other behind.

Modern airscrew theory, which is an advancement from the simple Drzewiecki theory, in that an attempt is made to take into account the velocity with which the air flows into the front of the airscrew, is considered in detail. One of the shortcomings of this theory is the difficulty of estimating accurately the magnitude of the inflow velocity which should be used with the aerodynamic data of aerofoils. A recent investigation at the National Physical Laboratory, on the distribution of pressure over the entire surface of an airscrew blade—an account of this investigation has not yet been published—has greatly illuminated this aspect of the airscrew problem. A theory developed from the data of this investigation takes into account the interference on a blade element of the neighbouring parts of the blade and also allows the distribution of inflow velocity along the blade to be calculated. It is shown that the inflow velocity, which should be used with the aerodynamic data of aerofoils, is a function of the position of the blade element, and also of the working conditions of the airscrew; it also shows that the magnitude of this velocity differs from that calculated from the Froude momentum theory. When the empirical data of these researches are available there would appear to be no reason why the performance of an airscrew, which does not twist, should not be calculated with very good accuracy.

The variation, with different types of airscrew, of the empirical power correction factor K*e*, needs explanation. As defined by Mr. Watts, K*e* is the ratio of the engine power to the power calculated from the airscrew analysis, and has a value which may be greater or smaller than unity. Mr. Watts suggests that some of the discrepancy between the theoretical and practical values of the power may be due to the body interference. Undoubtedly, the body influences the power absorbed by the airscrew, although in the light of the investigation to which reference has just been made, the reviewer is of the opinion that most of the discrepancy is due, firstly, to the twisting of the blades under load and, secondly, to an incorrect estimation of the distribution of inflow velocity along the blade. In any case the value of K*e* is not a criterion of the accuracy of the aerodynamic theory until the necessary correction for the twisting of the blade under load has been applied.

Mr. Watts shows that, to obtain the best all-round efficiency over the working range, the airscrew should be designed so that, at the maximum horizontal flight speed, a blade element has an angle of incidence of about 2·5 deg. less than the angle of the maximum value of L/D, which corresponds very closely to an angle of incidence, as measured from the chord, of 0 deg. The flow of air through an airscrew and the mutual interference of an airscrew and body are the subjects of Chapter IX. As would be expected, the work also contains a thorough discussion of the problem of the strength of an airscrew, with an outline of the methods of practical computation. In view of the non-uniform distribution of loading, the unsymmetrical blade shape, and the heterogeneity of the physical properties of the wood from which the airscrew is made, anything like an accurate calculation of the magnitude of the working stresses on an airscrew is a matter of great difficulty and well outside the scope of the methods of a drawing office. Practical experience has shown, however, that the simple method of calculating the working stresses, as now commonly adopted, is quite reliable, especially as a blade needs to be made sufficiently stout to withstand ordinary wear and tear. The later chapters of the book deal with problems of general interest such as gearing, tandem-airscrews, the variable pitch airscrew, and construction.

It is perhaps somewhat unfortunate that throughout the book Mr. Watts has used the term "propeller" in preference to the term "airscrew," which has been recommended by the Technical Terms Committee of the Royal Aeronautical Society. Mr. Watts admits in the preface that the more logical arguments are in favour of the term "airscrew," but says "language is not based on logic, but that custom and usage are the ultimate sanctions of the use of words." One cannot but feel that Mr. Watts has lost a golden opportunity of giving "custom" an impetus in the right direction. In conclusion, the work appears to be very thorough, and it should certainly be studied by all who profess to take an interest in the subject.

An Elementary Treatise on Differential Equations and their Applications. By H. T. H. Piaggio, M.A., D.Sc. London: G. Bell and Sons. [Price 12*s.*]

The story is told of Clerk Maxwell that a student went to him with one of his works and complained rather aggrievedly that he had worked at a paragraph for two hours and could not follow why "so and so is obviously so and so." Maxwell replied that when he wrote the passage it was obvious to him but he confessed that it had taken him two months to see it clearly, and he counselled the student, for his own good, to spend some time on it and thrash it out. No student, we think, will ever go to Dr. Piaggio with such a complaint, for the book under review contains no such gesture of impatient superiority as "It is obvious that ——." Dr. Piaggio's students are told in the preface that some portions of the book are much harder and much more difficult than others.

Maxwell, if the above story of him be true, would throw his pupils into the water and encourage them to strike out and swim. The author of this book fits his student with corks and water-wings, and occasionally holds him up with a life line as well. Page 14, for instance, is, we think, much too helpful, for example—

"$$\frac{-2}{v-1} = \log(x+c)$$

but

"$$v = \frac{y}{x}$$

so

"$$\frac{-2}{v-1} = \frac{-2}{\frac{y}{x}-1} = \frac{-2x}{y-x} = \frac{2x}{x-y}$$ "

Surely the reader who requires such bottle feeding will not go far in such a subject. It may be argued, on the other hand, that if the mind is relieved of algebraic work then more attention can be given to the main principles under discussion. We are, however, inclined to think that a book which requires a little pencil work, in the margin say, to fill in a step, will be better remembered than that which can be read without a pause. But this is pedagogy, and no doubt Dr. Piaggio has had more teaching experience in this subject than we can claim.

The object of the book, as the author states, is to give an account of the central parts of the subject in as simple a form as possible, suitable for those with no previous knowledge of it, and yet at the

same time to point out the different directions in which it may be developed. The author has succeeded in his object. After the historical introduction he deals in fourteen chapters with elimination, first order and first degree, linear equations with constant coefficients, simple partial differential equations (excellently brought into Chapter IV), equations of first order but not of first degree, singular solutions, miscellaneous methods for equations of second and higher orders, numerical solutions, solutions in series, existence theorems, ordinary equations with three variables and the corresponding curves and surfaces, partial differential equations of the first order—particular and general methods, and partial differential equations of the second and higher orders. The chapter on numerical solutions, enriched by Dr. Piaggio's own original work, is exceptionally good and should be of great value to the applied mathematician. Many of the exercises are taken from physics, and the author points out the physical significance of the symbols used in such examples. In nearly every case engineering theory has followed practice and though the same cannot be said so sweepingly about the relation of differential equations to physics and geometry, yet the relation is intimate and it is amazing that so many writers on differential equations have neglected to give interest to their work to the extent that Dr. Piaggio has done. Further interest is given by brief biographical foot-notes on the great mathematicians. The author rightly puts Lagrange as the greatest mathematician of the eighteenth century. His greatness might have been emphasized by the anecdote of the Revolution; Citizen Lagrange was asked what he would do for the Republic. Said he, "I will teach arithmetic."

In this book there are few faults and none of them serious. We have suggested that the volume is written for weaklings, but the good student who recovers from his boredom in the early pages will have his reward in the later parts of the book. The type is not of the best; the *t*'s and *f*'s being badly crossed at times, presumably the present cost of production has kept the type smaller than, say, in Sir George Greenhill's beautifully printed books. Lastly, Bernouilli is mentioned on page 12, but on other pages the author shows that he knows better.

BOOKS RECEIVED.

Elastizität und Festigkeit. Von Dr. Ing. C. Bach. Berlin: Julius Springer. [Price 88 marks.]

Johoms Hilfsbuch fur den Schiffbau. Von Dr. Ing. E. Foerster. Vols. I and II. Fourth edition. Berlin: Julius Springer. [Price 170 marks.]

Coal in Great Britain; The Composition, structure and Resources of the Coalfields, Visible and Concealed, of Great Britain. By Walcot Gibson, D.Sc., F.G.S. London: Edward Arnold. [Price 21*s.* net.]

Die Achate. Von Raphel Ed. Liesegang. Dresden and Leipzig: Theodor Steinkopff. [Price 12 marks.]

Ertragreichster Ausban von Wasserkräften. Von. Dr. Ing. Leiner. Munchen and Berlin: R. Oldenbourg. [Price 40 marks.]

Business Research and Statistics. By J. George Frederick. London: The Library Press, Limited. [Price 15*s.* net.]

Nationalisation of Industries; A Criticism. By Lord Emmott. London: T. Fisher Unwin, Limited. [Price 2*s.* net.]

Report of the Steel Research Committee founded by the Institution of Automobile Engineers and the Society of Motor Manufacturers and Traders on an Investigation Conducted to Establish the Mechanical Properties of the British Standards Wrought Automobile Steels. (British Engineering Standards Association Report No. 75) and Factors Governing Testing Procedure in Connection therewith. October, 1920. Sheffield: J. W. Northend, Limited, Printers.

Deeds of a Great Railway; A record of the Enterprise and Achievements of the London and North-Western Railway Company during the Great War. By G. R. S. Darroch. London: John Murray. [Price 15*s.* net.]

The Gyroscopic Compass; A Non-Mathematical Treatment. By T. W. Chalmers, B.Sc., A.M.I.Mech.E. London Constable and Co., Limited. [Price 11*s.* net.]

Commercial Airships. By H. B. Pratt, M.I.N.A. London: Thomas Nelson and Sons, Limited. [Price 15*s.* net.]

A Treatise on Reinforced Concrete. By W. Noble Twelvetrees, A.I.Mech.E. *Including the New Standard Notation of the Concrete Institute. With a Foreword on Standard Notation for Engineering Formulæ.* By E. Fiander Etchells, A.M.Inst.C.E., A.I.Mech.E. London: Sir Isaac Pitman and Sons, Limited. [Price 21*s.* net.]

The Dynamics of the Aeroplane. By Rene Devillers Translated by Captain Wm. John Walker, R.A.F. London: E. and F. N. Spon, Limited. [Price 21*s.* net.]

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Calcul des Organes des Machines. Par J. Boulvin. Paris: Gauthier-Villars et Cie. [Price 45 francs.]

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The Daily Mail Year Book, 1921. Edited by David Williamson. London: Associated Newspapers, Limited. [Price 1*s.* 6*d.* net.]

Cours de Micanique Générale. Introduction à l'Etude de la Mécanique Industrielle. Par Emile Cotton. Paris: Gauthier-Villars et Cie. [Price 16 francs.]

The Testing of Motive-Power Engines, including Steam Engines and Turbines, Locomotives, Boilers, Condensers, Internal-Combustion Engines, Gas Producers, Refrigerators, Air Compressors, Fans, Pumps, &c. By R. Royds, M.Sc., A.M.I.Mech.E. Second edition. London: Longmans, Green and Co. [Price 21*s.* net.]

Hydraulics with Working Tables. By E. S. Bellasis, M.Inst.C.E. Third edition. London: Chapman and Hall, Limited. [Price 18*s.* net.]

Cost Accounts: The Key to Economy in Manufacture. By W. Strachan. Fourth edition, revised and enlarged. London: Sweet and Maxwell, Limited. [Price 10*s.* net.]

JOURNAL DISPLACEMENTS IN LUBRICATED BEARINGS.

In his experiments on lubrication, Beauchamp Tower took some measurements of the eccentric positions assumed by a journal when running in a lubricated bearing at various speeds. Some more precise measurements, made by a new optical method, of these displacements were conducted last year at the Reichsanstalt by V. Vieweg and A. Wetthauer, and subsequently described in the *Archiv für Elektrotechnik*. The experiments were made to test the theory of journal lubrication which Gümbel explained before the Schiffbautechnische Gesellschaft (in the Jahrbuch, 1917, page 236), and which he subsequently confirmed by measurements of his own. According to Gümbel there would, in the first instance, be dry or semi-dry friction even in a lubricated bearing owing to the roughness of the two surfaces in contact. When the journal is turned, it is first lifted slightly and displaced, with clockwise rotation, to the right. When the journal is lifted higher, and the interlocking projections became entirely disengaged, the friction will be liquid, and the journal is displaced to the left. The method by which Vieweg and Wetthauer measured the displacements is the following. On the front of the journal they fixed a metal plate bearing a cross-ruling of dark lines, like a graticule; they watched this plate through a microscope to determine the centre about which the journal was actually rotating at any moment. If the centre coincided with an intersection of two of the crossed lines, that point would appear dark and surrounded by more or less distinct dark circles provided the speed was sufficiently high as no longer to show the network of lines. If the centre coincided with a light spot between the crossed lines, the observer would see a light central spot surrounded by a small dark circle and further by very faint rings.

The main measurements were made on an electric motor of 50 h.p., resting with its journal, 250 mm. long, 65 mm. diameter, in a full bearing, and run at speeds up to 850 r.p.m. by belting. It was found that the direction of the belt pull, from right or left, made no difference in the measurements. During the first period of dry or semi-dry friction the shaft vacillated, and exact measurements were hardly possible. The lift of the centre during this period amounted to about 10 or 15 μ, and that would correspond to the sum of the heights of the rough spots on two surfaces, of journal and bearing. The shaft then became more steady, but the displacements in μ ($1\ \mu = 0{\cdot}001$ mm.), both in the vertical (h) and in the horizontal (e), increased as the speed increased. We reproduce a few of the figures obtained when lubricating with two oils, I and II, the second being a petroleum of low viscosity.

I, r.p.m.: 100, 215, 500, 760; $h = 48{\cdot}4$, 69, 86, 92 μ.

I, r.p.m.: 52, 90, 165, 450, 560; $e = 21{\cdot}4$, 26·5, 34·2, 35·9, 29·1 μ.

II, r.p.m.: 80, 325, 625, 785; $h = 14{\cdot}3$, 33·1, 45·9, 46·8 μ.

II, r.p.m.: 145, 305, 435, 710, 855; $e = 26{\cdot}5$, 32·5, 40·2, 45·3 μ.

Experiments made with other motors give similar curves. In all cases, however, the curves changed very much when the motor was run in the opposite direction, and though that fact was not quite unexpected, it could not be properly explained. We should say that Vieweg wished chiefly to determine the thickness of the oil layers, and the title of his paper speaks of "Determination of the Thickness of the Oil Layers in Bearings," though he actually determines the displacements.

ROYAL METEOROLOGICAL SOCIETY.

The first monthly meeting of this society for the present session was held on Wednesday, the 17th inst., at the Society's Rooms, 70, Victoria-street, Westminster, Mr. R. H. Hooker, M.A., President, in the chair.

A paper by Messrs. C. E. P. Brooks and H. W. Braby, on "*The Clash of the Trades in the Pacific*," was read. This is a discussion of the mechanism of rainfall in the equatorial Pacific. The north-east and south-east trades are converging winds, and there must be forced ascent. Considering the months January to June, and first the area east of 180 deg. longitude, we find the trades meeting at a low angle. The south-east wind is the warmer and therefore the less dense, and rises above the north-east wind on a long slant, beneath which eddies are formed, giving occasional west winds. From the rising south-east trade rain is condensed and falls through the north-east or west winds. East of 180 deg. longitude the trade winds meet almost at right angles, and as their densities are the same they mingle and produce a great volume of rising air forming a low-pressure area, into which air is drawn from all sides. This low-pressure area is a mobile "action centre" whose position determines the character of the season—if it lies far to the west the season is dry, if it takes an easterly position the season is wet.

A paper on "*The Mirage*," by Dr. W. H. Steavenson, F.R.A.S., who had recently made a six months' study of the phenomenon in Egypt, was also read. The visibility of the mirage was found to be dependent solely on the distribution of temperature near the ground, as determined by the altitude of the sun. The appearance was therefore not necessarily associated with hot weather, and had, in fact, been well seen when the shade temperature was below 50 deg. F. Investigations had shown that the old reflection theory was untenable, and that the phenomenon was purely a refraction effect. The appearance of the mirage was subject to variations which were dependent upon such factors as the contour of the ground, the height of the observer, and the altitude of the sun. The paper was illustrated by actual photographs of the mirage, taken by Dr. Steavenson with a telephoto lens.

The late Mr. Edward Hayes.—We regret to have to announce the death, which occurred on the 15th inst., at his residence, "Mansefield," Stony Stratford, of Mr. Edward Hayes. Mr. Hayes was the owner of the well-known firm of marine engineers and launch builders, Watling Works, Stony Stratford, which had been carried on under the same name since 1840. After serving a pupilage of three years at the Watling Works under his late father, he spent a short time with another firm of engineers; he then returned to the Watling Works, in the management of which he took part from 1901 until 1917. The works became his property on the death of his father, in 1917. This was at a time when they were engaged on contracts for the supply of steam tugs to the War Office, Admiralty and foreign Governments. This work Mr. Hayes continued until the conclusion of the war, since when he had been engaged on the same class of work for shipping companies. The last vessel he built was for the Booth Steamship Company (London), Limited; this was completed in August last. Mr. Hayes was elected a member of the Institution of Naval Architects in March last. He was only 40 years of age. He died from pneumonia after only five days' illness. He leaves a widow and a young daughter. A brother of his is in the Indian Army.

STERILISATION OF WATER BY CHLORINE GAS.*

By Captain J. Stanley Arthur, O.B.E., B.Sc., A.I.C., R.A.M.C. (T.F.), of London.

The aim of all water purification for drinking purposes is to produce a clear, tasteless water free from harmful bacteria. The very best methods of filtration can only bring about a reduction of 98 per cent. of the total number of bacteria present in the water. In order to remove the remaining 2 per cent. of bacteria, and thus render the water perfectly safe, a process of sterilisation must be carried out. This process also acts as a safeguard in case of a breakdown of a sand filter.

Many methods have been devised to carry out the complete sterilisation of water, and they can be divided into physical and chemical methods. The physical methods, which include sterilisation by heat and by ultraviolet light, although quite efficient, are more difficult to operate and are more expensive than chemical methods. Chemical methods are cheap and comparatively easy to manipulate, and are capable of very exact operation. Chlorine, either as the free element or combined, as in bleaching powder, is the chemical which is most largely used. Bleaching powder, or chloride of lime, was first used to sterilise a supply of drinking water in 1897, at Maidstone, where an epidemic of typhoid was raging. Its use was attended with very successful results, typhoid being very rapidly stamped out.

Chlorine, in the gaseous condition, although used in America to a small extent for some time, has only come into general use during the last few years. The amount of chlorine, either as a gas or from bleaching powder, required to sterilise water is quite small. For a sedimented and filtered water less than half a part of chlorine per million parts of water is sufficient for complete sterilisation, and for crude water, for example, Thames water at Kew, only three to four parts per million are required, provided that this chemical is allowed to remain in contact with the water under treatment for not less than 20 minutes.

At the outbreak of war the only method of water purification that could be carried out in the field was embodied in the water cart. In this apparatus water was pumped from the source, treated with aluminium sulphate, with or without the addition of an alkali, filtered through a cloth-covered cylinder on which the aluminium hydroxide, produced by the hydrolysis of the aluminium sulphate, was deposited and which formed the real filtering medium. After filtration the water was treated with bleaching powder—chloride of lime—to produce sterilisation. It was soon found that the amount of bleaching powder that was being added was often greatly in excess of that actually required to produce sterilisation. Attempts were made to devise a simple method by which the amount of bleaching powder required to sterilise any water could be determined in the field. The first suggestion was made by Professor James Woodhead, and the actual details resulting in the fitting up of a case containing the necessary apparatus and chemicals with instructions for carrying out the test were worked out at the Royal Army Medical College under the direction of Sir William Horrocks (see appendix, page 720). With this test case, known in the army as the "Case, Water Testing Sterilisation," and the water cart as the starting point, the whole of the great water purification scheme of the army has been built up. That the methods adopted have been successful is seen from the fact that throughout the war there has been no epidemic of any water-borne disease.

The first advance upon the water cart was the production of a type of water-purification plant which sterilised water by a continuous process at the rate of 125 gallons per hour, using bleaching powder as the sterilising chemical. This was a distinct improvement over the water cart, which only worked intermittently. From this small type a much better and larger plant was devised giving a continuous output of 400 gallons per hour and in which the excess of chlorine that was left in the water after sterilisation was completed, was removed by means of a solution of sodium bisulphite. This plant was fitted up on a 3-ton motor lorry and a large number were sent to France and known as Nos. 1 and 2 Water Tank Companies. These companies had a number of water purification plants which, in addition to being able to sterilise water, could also remove poisons from it. A large number of tank or carrying lorries were also attached to these companies for the purpose of transporting the purified water.

It was felt that these plants had several disadvantages. The output of water was relatively low and there was a considerable amount of work entailed in preparing the solutions used in the process. Attempts were made to overcome these defects and finally, by the introduction of the use of chlorine gas, a new type of water-purification plant was devised which has been adopted, with minor alterations to meet special conditions, as the standard of the British Army. The principle of this plant has been applied to all types of water purification plants in use in the field.

A considerable amount of work had been done in America on the question of sterilisation of water by means of chlorine, and great difficulty had been experienced in devising a satisfactory method of administering this gas to water. In 1912 a patent was granted to Major Darnell, of the American Army, for an apparatus for the administration of chlorine gas to water for the purpose of sterilising it.†

This apparatus, Fig 1, below, consists of a cylinder of liquid chlorine connected to a pressure regulator, A. This regulator controls the flow of chlorine from the cylinder by acting on a valve, B, by means of levers, the regulator itself being in turn controlled by the rate of flow of the water that is being treated. The regulator consists of an iron case divided by a circular diaphragm, thus forming two similar compartments, a and a^1. The diaphragm is connected at the top, by means of levers, to the easily adjusted valve, B. The lower portion of the case, which is air-tight, is connected to a small compressor, D, through a reservoir, C. This compressor is worked by means of a turbine, E, which is driven by the water that is being treated. As the water flows through the turbine the compressor increases the pressure of the air in the lower portion of the regulator. This pressure will vary according to the rate at which the water is flowing through the turbine and will thus act on the diaphragm and control the rate at which chlorine may pass through the valve, B. Theoretically, the apparatus is automatically controlled, but difficulty was experienced in successfully operating it.

Leavett Jackson and the Electro Bleaching Gas Company constructed apparatus to administer chlorine

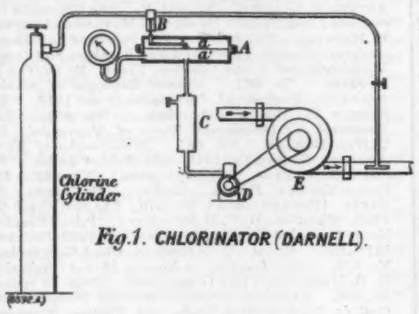


Fig. 1. CHLORINATOR (DARNELL).

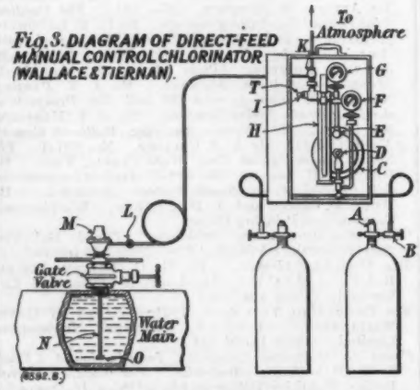


Fig. 3. DIAGRAM OF DIRECT-FEED MANUAL CONTROL CHLORINATOR (WALLACE & TIERNAN).

to water, but the chlorinating apparatus which has proved commercially successful is that made by Messrs. Wallace and Tiernan, of New York, who, working upon the lines of the Darnell apparatus, have produced two types of chlorinators which have proved very successful in operation. Other attempts have been made to produce apparatus for the purpose of administering chlorine gas to water, but up to the present those constructed by Wallace and Tiernan appear to be the best and most accurate.

The two types of apparatus manufactured by Wallace and Tiernan are the same in principle, but differ in that, in the direct-feed type, chlorine gas is added directly to the water under treatment, while in the solution-feed type the gas is first dissolved in water and this solution added. Both types have as an object the delivery of a continuous supply of chlorine to water at a known indicated uniform rate, which is independent of any changes of pressure of the chlorine in the containing cylinder. The first instrument—a direct-feed type—was brought to England in August, 1916, and placed at the disposal of the War Office by Messrs. United Water Softeners, Limited.

An experimental plant was constructed and exhaustive tests were made upon the canal water at Brentford, Middlesex, with the object of determining if chlorine were an efficient sterilising chemical and if the apparatus were satisfactory. Many of these tests extended over a continuous period of 72 hours and the results of one test are given in the table (page 720). At the conclusion it was found that: (1) chlorine is a most efficient chemical for sterilising water; (2) the apparatus is extremely satisfactory, easy to manipulate and accurate; (3) water so treated has a far less marked taste than water similarly treated with bleaching powder.

During the tests it was suggested that the use of sulphur dioxide gas to remove the excess of chlorine left in the water after completion of sterilisation would render the process more efficient in that the purified water would be free from the slight taste imparted to it by chlorine, and would render the removal of this taste much easier than would the use of a solution of sodium bisulphite. This method has been adopted as standard for all types of water purification plants in the Army, except very small ones which are too small to allow of this process to be economically used. The direct-feed type of Wallace and Tiernan chlorinator was adopted as standard.

Direct-Feed Chlorinator (Fig. 2, and Figs. 3 to 6, page 717).—The apparatus is essentially one which meters chlorine gas and which at the same time delivers the gas to a constant pressure. Chlorine is stored in steel cylinder as a liquid, and the pressure within such a cylinder will depend upon the temperature at which the cylinder happens to be. The pressure of liquid chlorine at 0 deg. C. is 54 lb. per square inch, and at 50 deg. C. (122 deg. F.) it is 216 lb. per square inch. The pressure registered within a cylinder of liquid chlorine is the pressure which the vapour of liquid chlorine, that is, chlorine gas exerts while in contact with liquid chlorine at the temperature of the cylinder and its contents. A rise in temperature will produce a rise in pressure and *vice versa*.

If gaseous chlorine is allowed to escape, by opening a valve on a cylinder of liquid chlorine, some of the liquid must evaporate to account for this escape. This will affect the pressure of the gas in the cylinder, for liquid chlorine is a bad conductor of heat and consequently

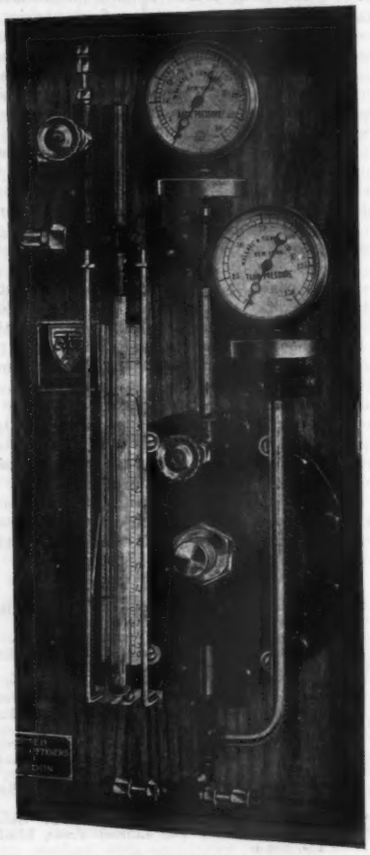


Fig. 2. Wallace-Tiernan Chlorinator, Direct-Feed Manual Control.

most of the latent heat required to evaporate it will be obtained first from the liquid chlorine itself and not from the surrounding atmosphere, and as a result the temperature of the liquid chlorine inside the cylinder will fall and thus produce a fall in pressure. The density of chlorine will also increase with a fall of temperature, and, consequently, the volume of chlorine gas that may leave a cylinder is not a direct measure of its mass.

The Wallace and Tiernan chlorinator, Fig. 2, above, is actually a reducing valve and meter combined, and consists of three main portions: (1) the compensator, in which alterations of pressure in the cylinder are compensated, Fig. 4; (2) the metering or flow-measuring apparatus combined in the orifice, scale, and manometer, Fig. 5; (3) the check valve—or back-pressure valve—and diffuser, Fig. 6.

Compensator.—Explanation of working, Fig. 3: Under normal conditions when the instrument is started, the valve on the cylinder, A, and the auxiliary tank-valve, B, control-valve, E, blow-off valve, K, and auxiliary valve on check valve, L, are shut. The auxiliary valve, L, fitted to check valve, M, and main tank valve, A, are opened, the control valve, E, being kept closed. The auxiliary tank valve, B, is opened slowly. Chlorine now enters the compensator, C, through the small needle-valve (1, Fig. 4), and passes down the two holes (2), and fills the space between the front portion of the compensator, and the silver diaphragm (6, Fig. 4). The pressure in this space increases and forces back the silver diaphragm (6), and the strengthening disc (5)

* Paper read before the Institution of Mechanical Engineers on Friday, November 19, 1920.

† American patent, No. 1007647, October 31, 1912; Journal American Public Health Association, November, 1911.

against the spring (4), and at the same time allows the spring (3) to close the needle-valve (1).

The pressure of the chlorine in the cylinder is indicated by the tank pressure gauge, F, Fig. 3. If the control valve, E, is slowly opened, the chlorine will pass through this valve and slowly build up a pressure which is registered on the back-pressure gauge, G. This pressure will be exerted on the back of the silver diaphragm (6, Fig. 4) as there is a small hole (7) drilled through the apparatus for this purpose. During this operation the control valve, E, is only opened sufficiently to cause the liquid in the manometer tube, H (Fig. 5) to rise in the small inner tube (9) and remain in sight. If opened too much, the liquid in the manometer tube will be driven up into the space at the top, and it may get into the compensator or orifice cap, I and T.

As chlorine passes through the control-valve, E, the pressure on the front side of the diaphragm (6) will fall, consequently the pressure on the back side of this diaphragm—due to a spring (4) and the back pressure—will cause the diaphragm (6) to press on the needle-valve (1) and thus allow more chlorine to enter. As soon as the back and front pressure are equal, a state of equilibrium is maintained in the compensator. Any chlorine passing out of the compensator will tend to increase the pressure on the check-valve, M (Fig. 6), and more chlorine will consequently pass through the needle-valve (1) due to the slight breathing movement of the silver diaphragm, the chlorine entering the compensator from the main cylinder at the same rate as it passes through the check-valve to the diffusor. Thus a steady flow of chlorine is maintained, the chlorine leaving the apparatus at a constant pressure set up by the check-valve, M.

Manometer and Orifice and Scale (Fig. 5).—The outer glass tube of the manometer, H, is connected by means of the small tube (10) to the orifice, I, which is made of glass, and which varies in size according to the amount of gas that the instrument is required to pass, and the small tube (9) to the orifice cap, T. As chlorine flows from the compensator, it meets the orifice and is necessarily checked in its flow, and subsequently a pressure is set up before the gas passes through the orifice. The difference in the pressure of the chlorine before and after it has passed through the orifice is proportional to the flow of the gas, as in a Venturi water-meter. Since the back pressure set up by the check-valve is constant, the chlorine will be passing from the orifice at a steady pressure, and will, therefore, be unaffected by any change of pressure to which the chlorine may be subjected. The pressure set up by the flow of the chlorine through the orifice is indicated by the height of the liquid in the manometer tube, and this height is read by means of an adjustable scale which has been graduated, experimentally, for the orifice in question, in pounds of chlorine per hour. Any desired quantity of chlorine can be allowed to pass from the instrument, within the range that the orifice can pass, by opening or closing the control-valve, E, Fig. 3, on the compensator, C.

Check Valve (Fig. 6).—The check-valve consists of a silver-plated brass or copper stem, N, through which runs a silver tube (12). To the open end of this tube is attached the diffusor, O, which consists of a porcelain ring into which two discs of alumdum are cemented. The other end is attached to a perforated silver hemisphere (14) which fits inside the main portion of the valve, and is fitted with a needle-valve (15) which is kept open by a spring (16). Closing this hemisphere is a silver corrugated disc (17) with a similar strengthening disc of copper (18) on the top of it. Acting on this is a spring (8) to which is fitted an adjusting screw (20). This spring acts on a segmented disc (19) which in turn acts on the two diaphragms and closes the needle-valve. No chlorine can pass out of the check-valve, until the pressure within is sufficient to overcome the pressure of the spring (8) and so lift the needle-valve. This pressure is the back pressure, and is usually set at 25 lb. per square inch.

By means of the apparatus the chlorine enters the compensator at any pressure and, after passing through it to the orifice, it is metered, and leaves the apparatus at a constant pressure, and is forced into the water through the diffusor, which breaks up the gas into very small bubbles. The amount of chlorine passing through the apparatus is regulated by means of the control-valve, E, Fig. 3, and when once set will continue to deliver chlorine at the set rate until the cylinder is empty. For a temporary stoppage, it is only necessary to close the auxiliary tank-valve, B, and on re-starting, to open this valve. The apparatus can be emptied of chlorine by means of the blow-off valve, K.

It is absolutely essential that moisture should be kept from getting inside the apparatus, as although dry chlorine has no effect, moist chlorine will rapidly corrode the metal parts of the apparatus. It is also necessary to keep the cylinder of chlorine at about the same temperature as the chlorinator, as at low temperatures chlorine under pressure very easily liquefies, and if the instrument is colder than the cylinder, liquid chlorine will collect in it and render the flow of chlorine unsteady.

The solution-feed type of apparatus, Figs. 7 and 7A differs from the direct-feed type in that the chlorine, after it passes from the compensator, passes to a bubble meter in which the bubbles of chlorine are seen and counted and are dissolved in water. The rate of flow of the chlorine is determined by the rate of the bubbles, and regulated by means of the control-valve on the compensator. After the bubbles of chlorine have dissolved in the water that is led to the bubble meter, and which is under constant agitation, it is injected into the water that has to be sterilised. This type of instrument has the advantage over the direct-feed type in that the actual chlorine that is being used is seen, and that it can be used to deliver smaller amounts of chlorine than the direct-feed type. It is, however, slightly more complicated, and requires more care in fitting up, but it is, if anything, more accurate than the direct-feed.

The direct-feed type has been adopted throughout the water purification plants in use in the Army, and they have given every satisfaction. The makers guarantee an efficiency and accuracy of at least 96 per cent., and on several tests the accuracy has been almost 100 per cent.

The purification plants in the Army in which the chlorine-sulphur dioxide process has been adopted as standard can be divided into three classes: (1) portable plants built on motor lorries, Figs. 8 and 9, and Figs. 10-14, pages 718 and 719; (2) portable plants built on barges, Fig. 15 (page 719); (3) stationary or land plants, Fig. 16 (also on pages 718 and 719).

The first class is primarily for use with an army moving into occupied territory, in which the usual sources of water have been destroyed or rendered useless. The second serves to some extent the same purpose,

Fig. 4. COMPENSATOR (C Fig. 3) IN SECTION, SEPARATED. CHLORINATOR (WALLACE AND TIERNAN).

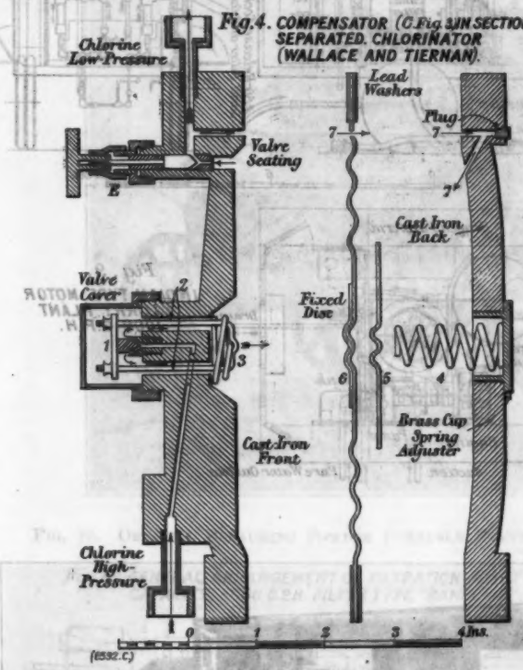


Fig. 5. ORIFICE (I) AND MANOMETER (H).

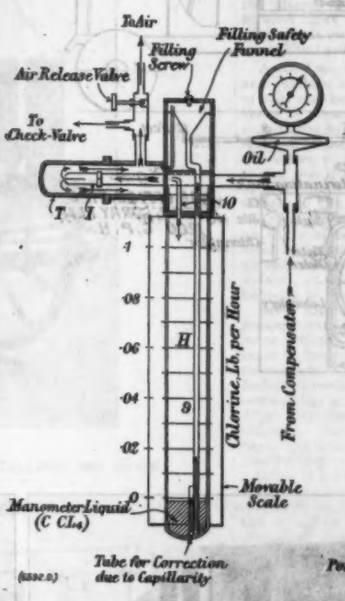
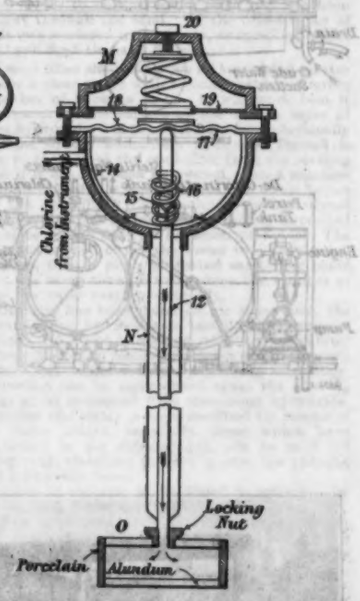


Fig. 6. CHECK-VALVE M, AND DIFFUSER O.



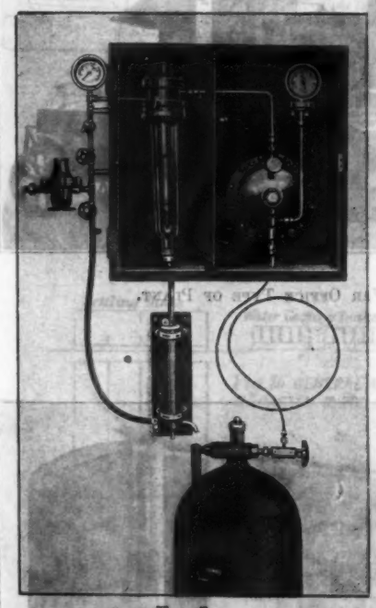
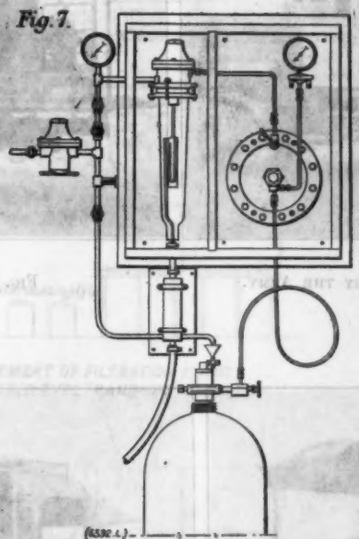


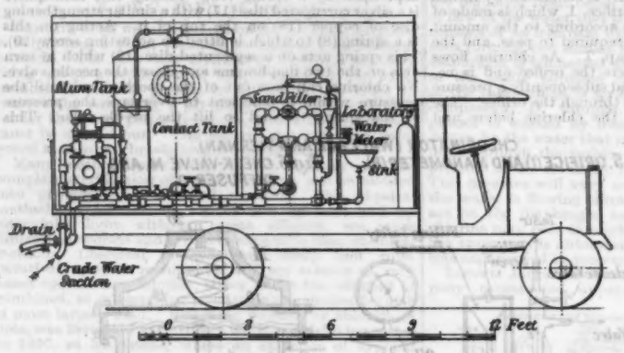
FIG. 7A.

Fig. 7.



FIGS. 7 AND 7A. SOLUTION-FEED PULSATING METER.

PORTABLE PLANTS FOR THE STERILIZATION OF WATER BY CHLORINE GAS.



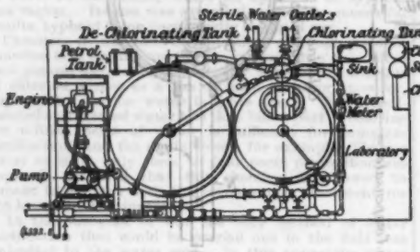
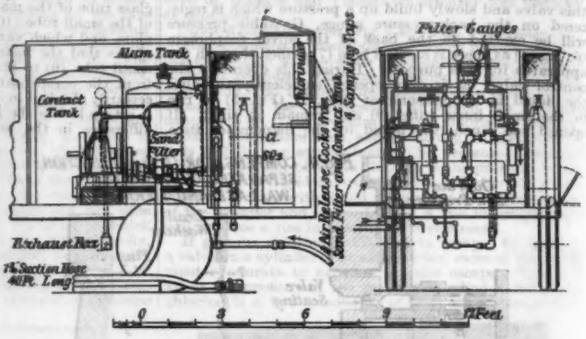


Fig. 8. WAR OFFICE TYPE MOTOR LORRY PLANT 1200 G.P.H.



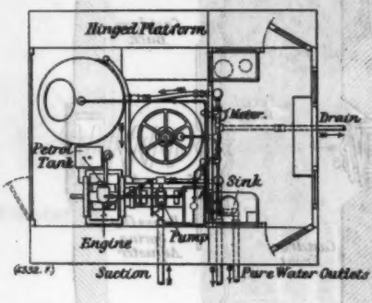


Fig. 9. INDIAN TYPE MOTOR LORRY PLANT 1000 G.P.H.

FIG. 11. ORIGINAL CHLORINE GAS PLANT USED BY THE ARMY.

FIG. 12. WAR OFFICE TYPE OF PLANT.

FIG. 13. WAR OFFICE TYPE OF PLANT.

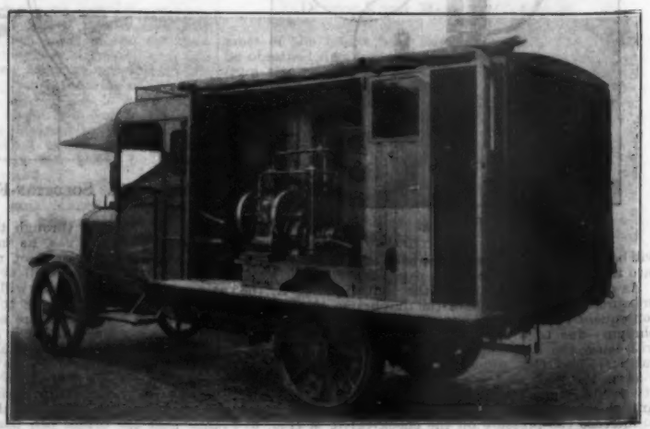


FIG. 14. INDIAN ARMY TYPE OF PLANT.

but on a larger scale, and the third is the standard type for supplying water to troops in the rear of operations, and for replacing the water supply of towns.

The process of purification is the same for all three types of plant, and can be divided into five main operations: (1) Coagulation of suspended matter by means of aluminium sulphate solution, or, if necessary, with this chemical and an alkali; (2) sedimentation of the water so treated; (3) filtration of the water after coagulation and sedimentation; (4) sterilisation, using chlorine gas; (5) dechlorination, using sulphur dioxide gas.

Under some circumstances it may not be necessary to treat chemically or sediment the water before filtration, but whenever the crude water contains a large amount of fine material in suspension, or is coloured by iron or clays, a preliminary chemical treatment is essential.

The five operations are carried out in slightly different ways by the three types of plants, each adopting that which is most convenient. Coagulation and sedimentation are carried out by the motor portable plants in canvas dams, but in the other types pre-treatment tanks form part of the plants. If it is necessary to pre-treat the water, the required amount of aluminium sulphate, or alum, together with lime or soda, if the water is very soft, is added to the water and well mixed. After standing for some time the water clears, and the suspended matter falls to the bottom with the aluminium hydroxide which has been formed by the hydrolysis of the aluminium sulphate. The cleared water is then led to the filters in such a way that the sediment in the pre-treatment tanks remains undisturbed. The filters, except those constructed by Ransome ver Mehr, consist of cylindrical iron tanks, filled with sharp clean sand resting on a bed of graded gravel, fitted with some arrangement for mechanically stirring the sand, and so constructed that water can be admitted from the top or the bottom.

Filtration always takes place through the sand from the top downwards. It is essential, however, that the filters should be completely filled with water from the bottom upwards, in order to remove all air from the sand and to form a solid bed of it free from possible cracks and air-channels. When this has been done, the direction of the flow of the water is reversed, and filtration commenced, the water passing in at the top of the filter and out at the bottom. The object of the mechanical stirring arrangement and the arrangement for sending the water up through the sand is to enable this to be back-flushed or cleansed after it has been in use for some time, thus removing the matter which has been filtered out on the top of the sand, and which gradually causes the filtration pressure to increase.

FIG. 10. ORIGINAL BLEACHING POWDER PORTABLE PLANT; 125 GALLONS PER HOUR.

Fig. 15. GENERAL ARRANGEMENT OF FILTRATION PLANT ON BARGE. CAPACITY, 8,000 G.P.H. FILTER TYPE "RANSOME."

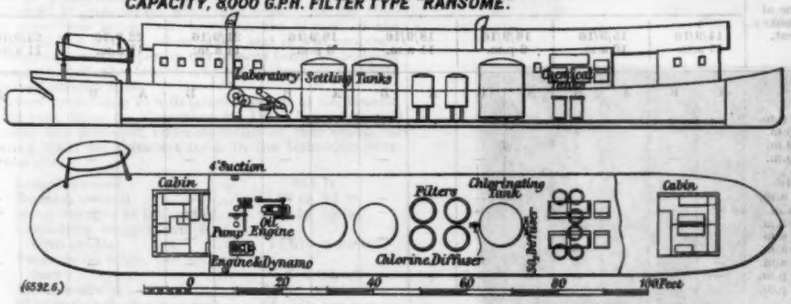
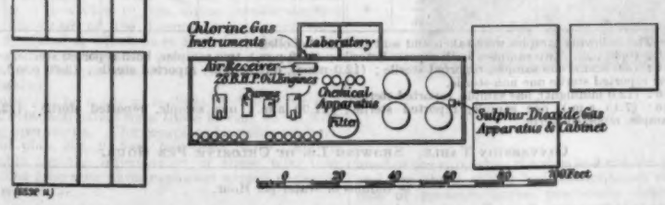


Fig. 16. GENERAL ARRANGEMENT OF FILTRATION PLANT. CAPACITY, 13,200 G.P.H. FILTER TYPE "RANSOME."



In the Ransome filter, used on some barge and stationary plants, a modification of the ordinary filter is used, a mechanical stirring arrangement being unnecessary as the surface of the sand is constantly shifting and being replaced by sand which has been automatically washed. In the earlier type of motor-lorry plant, in which weight was necessarily restricted, a mechanical stirring arrangement was not used, and back-flushing of the filter had to be carried out with crude water. This made it necessary, on starting the filter, to allow the filtered water to pass to waste, as it had not been filtered right through the sand. In the other types of plants this was rendered unnecessary, as sterilised water is used to back-flush the sand-filters.

A good sand filter should remove all suspended matter and produce a clear water with a considerable reduction of the number of bacteria in it. It will work best if there is present on the surface of the sand a layer of aluminium hydroxide. If the water has been chemically treated, some of the aluminium hydroxide formed is carried on to the bed of the sand-filter from the settling tanks, but if it has not been so treated, then a solution of aluminium sulphate is injected into the water before it enters the sand-filter. This solution is hydrolysed by the water and the aluminium hydroxide deposited on the surface of the sand as filtration proceeds. The filter bed thus formed clears the water to a very much greater extent than a plain untreated sand-filter could do and, at the same time, it will reduce the number of bacteria in the water very considerably.

After filtration has been going on for some time, the pressure on the filter bed increases, and filtration becomes more difficult. A point is reached when the sand-filter must be back-flushed to remove the layer of sedimentary matter which has collected on the top of the sand-filter. Before filtration can be commenced again the filtering surface has to be re-formed with aluminium hydroxide. After filtration the water is then sterilised by means of chlorine. Some plants, especially those which have been converted to use chlorine gas, can be used for sterilisation with bleaching powder in case the chlorine method should break down.

The amount of chlorine to be added is indicated by means of the test described in the Appendix (page 720), the complete apparatus and chemicals for which are contained in a case supplied to the troops, and known as "Case, Water Testing Sterilisation," unless the water has been examined bacteriologically. This indicated amount of chlorine is administered by the Wallace and Tiernan chlorinator, which is adjusted to deliver the correct amount of chlorine for the particular rate of output of the plant. The apparatus is graduated in pounds of chlorine per hour, and this is converted into parts of chlorine per million of water by means of a conversion scale (page 720). The adjustment of the flow of chlorine is carried out as described previously.

The filtered water is thus chlorinated and partly sterilised, but complete sterilisation takes place after the water has been in contact with chlorine for not less than twenty minutes. The period of contact is obtained by allowing the chlorinated water to pass through a large tank or series of tanks. These tanks are fitted with baffles to prevent short circuiting of the water. During the period of contact some of the chlorine is absorbed, and at the completion of this time the water is completely sterilised as is shown by obtaining negative results by the McConkey and neutral red agar tests. The water, although filtered and free from bacteria, contains some chlorine, and as a consequence has a slight taste. This taste can be completely removed by the addition of sulphur dioxide, the chlorine reacting with this gas to produce hydrochloric and sulphuric acids, or chlorides and sulphates, which, at the very great dilution at which they are present, cannot be detected by taste.

The sulphur dioxide is added to the water by means of a simple apparatus, which consists essentially of a check or back-pressure valve, to prevent the water under treatment entering the apparatus, and a fine adjustment valve for regulating the flow of the gas. A pressure gauge is fitted to indicate the pressure of the sulphur dioxide in the cylinder. The amount of sulphur dioxide to be added is determined by a simple chemical test which is repeated from time to time and, if necessary, any alteration of the fine adjustment valve made. The test is made by adding a solution of potassium iodide and starch to a small quantity of the water after it has been treated with sulphur dioxide. A blue colour is produced by the chlorine, and the amount of sulphur dioxide that is being added is adjusted until only that colour is produced which indicates that less than half a part of chlorine is present in a million parts of the treated water. This test is extremely delicate, for a definite blue colour is obtained with 0·2 part of chlorine per million.

The small amount of chlorine that is left in the water is for the purpose of preserving the sterility of it during the transit from the purification plants to the troops actually using it. If the water is required for use on the spot, the amount of chlorine left in can be reduced to an almost negligible quantity. On some of the larger plants a rather more elaborate dechlorinating instrument is used, differing only in detail from the above-mentioned type.

In field operations, the water which has been purified is either delivered to storage tanks, and from these to

pipe-lines or, as is the case with the mobile purification plants, to tank-lorries or water-carts. The small amount of chlorine that is purposely left in the water generally disappears by the time it reaches the troops, and consequently no taste of this chemical can be detected. It has been found possible, under some circumstances, to deliver water direct to the petrol tins used for carrying water to the trenches, thus saving a great deal of transport and its attendant difficulties, a matter of considerable importance in warfare.

Experience gained in the late war has shown that water purification installations using chlorine as the sterilising chemical are extremely efficient, simple, and cheap to operate, and that the water after treatment is without the characteristically objectionable taste which is associated with water that has been sterilised by means of chloride of lime. There is no question that, for installations of even a moderate size and even quite small ones that are in almost constant use, the chlorine-sulphur dioxide process is the best and most efficient one that can be adopted. Chlorine is cheap, it is easily transported and stored, and there is no loss or deterioration occasioned by even long storage. The process entails very little labour for making solutions, and the manipulation is extremely simple and easily learnt.

For very small plants, and those which are not in frequent use, the initial cost of a chlorine-sulphur dioxide installation is comparatively high, and for this reason chlorine will never replace entirely chloride of lime as a sterilising chemical for water. Chloride of lime, however, has one very serious disadvantage in that it is very easily decomposed by even a moderate temperature, and very great trouble was experienced in the early days of the war in providing a supply of sterilised water for the troops engaged in operations in the East. As soon as the chlorine-sulphur dioxide process was introduced, this difficulty was, to a very great extent overcome, but the process could not be economically applied to small plants which gave an output of only a few gallons per hour.

As a result of experimen's undertak n with the object of producing a sterilising chemical which was not easily decomposed by heat a new substance was introduced. This chemical is known as bromine bleaching powder,* and is very similar in properties to chlorine bleaching powder, except that it is not decomposed at temperatures as high as 100 deg. C. Bromine bleaching powder imparts a less objectionable taste to water than ordinary bleaching powder and is quite an efficient sterilising chemical.

From this survey of the water supplies of the Army it is evident that a supply of sterilised water can be maintained under almost any possible conditions by the use of one or other of the various types of water purification plants mentioned. So successful has the process been that new plants have been ordered for use in the East, Fig. 9 (page 718). These are lighter and more compact than those used in France, and are even simpler to manipulate and embody many small improvements in design which have been found to be desirable as a result of experience gained on active service in the war.

This paper would be quite incomplete if the invaluable work done on the subject of water purification for the Army, by Col. Sir William Horrocks, K.C.M.G., C.B., M.D., and his Advisory Board, was not fully acknowledged and emphasised. The work done by this Advisory Board of the Army Medical Service contributed to an enormous extent to the magnificent standard of health of the Army during the war. The whole of the work on water purification was under the direct control and personal supervision of Sir William Horrocks, and this paper only deals with a portion of this work, but it will serve to indicate what has been done to safeguard the water supply of the Army during the Great War.

The author is indebted to Messrs. The United Water Softeners, Limited, for their kindness in lending several of the blocks and photographs used for illustrating this paper.

APPENDIX.

Description and Method of Using the "Case, Water Testing Sterilisation," in connection with Chlorine Gas.

Description of Contents.

The contents of the case are as follows:—

(a) Six white enamelled cups, each holding ½ pint of water when filled to the brim. (b) One black enamelled cup with mark on the inside. (c) Two metal spoons, each holding 2 grammes when filled with bleaching powder level with the brim. (d) One stock bottle of zinc iodide and starch test solution and one dropping bottle. Three drops of the solution give a definite colour with water containing one part per million of free chlorine. (e) Six glass tubes or pipettes, each of such dimensions that a drop of standard bleaching powder solution delivered by it, when held in a vertical position, into a white cup filled with water gives a dilution of one part per million of free chlorine. (f) Four glass stirring rods, 12 pipe cleansers and two copies of instructions.

Method of Using.

Crude water is generally used. The test is best carried out while the plant is being prepared for work. The test takes about half an hour to carry out.

(1) A standard solution of bleaching powder is prepared in the black cup by putting into it one level spoonful of good bleaching powder, making it into a paste with a little water by stirring it with a glass stirrer and carefully breaking up all lumps. More water

* British Patent No. 14661–18.

Experimental Test on the Chlorination of Water by means of the Wallace-Tiernan Chlorinator. Brentford, September 12 to 15, 1916.

All chlorine was removed after sterilization by means of sulphur dioxide.

Time of Test.	Rate of Flow. Gallons per Hour.	Wallace-Tiernan Gauges.			Chlorine—Parts per Million.		
		Tank.	Back.	Manometer Level.	Injected.	A After 10 Minutes.	B After 30 Minutes.
12/9/16—							
2.30 p.m.	540	74·0	19·5	0·8	4·7	—	—
3.40 p.m.	770	70·0	19·5	0·57	3·6	3·0	2·7
4.30 p.m.	720	72·0	19·5	0·56	3·5	3·5	3·3
6.0 p.m.	600	75·0	20·0	0·55	3·5	3·2	3·2
8.30 p.m.	720	75·0	19·5	0·5	3·4	3·2	3·2
10.30 p.m.	640	75·0	19·5	0·525	3·5	3·3	3·3
13/9/16—							
1.0 a.m.	675	72·5	19·2	0·52	3·5	3·3	3·3
3.0 a.m.	675	71·0	19·1	0·52	3·5	3·3	3·3
5.0 a.m.	675	71·0	19·1	0·53	3·5	3·3	3·3
7.0 a.m.	675	73·0	19·4	0·54	3·5	3·3	3·3
9.15 a.m.	675	77·0	19·75	0·53	3·5	3·3	3·3
11.0 a.m.	640	82·0	19·75	0·5	3·5	3·3	3·3
2.0 p.m.	640	82·0	20·0	0·54	3·5	3·3	3·3
4.0 p.m.	640	77·0	20·0	0·53	3·5	3·3	3·3
14/9/16—							
5.30 p.m.	720						
6.0 p.m.	720	63·0	20·0	0·75			
7.0 p.m.	720	61·0	19·0	0·75	5·15	2·13	1·7
8.30 p.m.	720	57·5	18·6	0·79	4·1	1·77	0·9
10.0 p.m.	720	56·0	18·5	0·8	4·1	1·77	1·0
11.30 p.m.	720	55·0	18·5	1·06	5·3	2·1	1·95
15/9/16—							
1.0 a.m.	720	52·5	18·5	1·07	5·8	3·9	1·95
3.0 a.m.	720	50·0	18·5	1·07	6·9	3·8	3·2
5.30 a.m.	720	49·0	18·3	1·08	6·2	2·1	2·1
7.0 a.m.	720	48·0	18·1	1·1	6·2	2·2	1·6
9.0 a.m.	720	52·0	18·75	1·15	6·2	2·6	2·1
11.0 a.m.	720	65·0	19·1	0·55	4·7	4·4	3·4
1.0 p.m.	720	68·0	19·1	0·55	4·8	3·8	1·77
2.30 p.m.	720	70·0	19·2	0·55	4·4	3·8	1·7
3.30 p.m.	675	70·5	19·5	0·35	2·4	2·0	1·5
4.30 p.m.	640	70·5	19·0	0·17	1·4	1·2	1·2
5.30 p.m.	640	70·5	19·0	0·15	1·2	1·1	1·1

Remarks.—13/9/16: (4.30 p.m.), breakdown of pumping plant. 14/9/16: (5.0 pm..), started again after repairs; (6.0 p.m.), commenced chlorinating; (10.30 p.m.), chlorine increased. 15/9/16: (9.45 a.m.), chlorine reduced; (3.0 p.m.), chlorine reduced); (4.0 p.m.), chlorine reduced; (5.30 p.m.), test stopped.

Experimental Test on the Chlorination of Water—*continued.*

Time of McConkey Test.	McConkey Test—50 cm.³ Incubated at Brentford. Date and Time of Inspection.															
	14/9/16 11 a.m.		15/9/16 10 a.m.		16/9/16 2 p.m.		18/9/16 11 a.m.		19/9/16 3 p.m.		21/9/16 11 a.m.		22/9/16 11 a.m.		23/9/16 11 a.m.	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
4.30 p.m.		+														
6.0 p.m.	+	–	+	+												
9.0 p.m.		–		+												
11.0 p.m.		–		–		–		–		–		–		–		–
13/9/16—																
1.30 a.m.		–		–		–		–		–		–		–		–
3.0 a.m.		–		–		–		–		–		–		–		–
5.30 a.m.		–		–		+										
7.30 a.m.		–		–		+		–		–		–		–		–
9.45 a.m.		–		–		+										
11.30 a.m.	–	–	–	–	–	+	+	–		–		–		–		–
2.15 p.m.	–	–	–	–	–	–	+	–	+	+						
4.30 p.m.	–	–	–	–	–	–	–	+	–	+	–		–		–	
	16/9/16 2 p.m.		17/9/16 3.30 p.m.		18/9/19 11 a.m.		19/9/19 2 p.m.		21/9/19 11 a.m.		22/9/19 11 a.m.		23/9/19 11 a.m.			
7.20 p.m.	+		+		+											
8.45 p.m.	+		+		–		+									
10.30 p.m.	–		–		–	–	–	–	–	–	–	–	–	–		
11.45 p.m.	–		–		–		–		–		–		–			
15/9/16—																
1.0 a.m.	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
3.0 a.m.	–		–		–		–		–		–		–			
5.0 a.m.	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
7.0 a.m.	–		–		–		–		–		–		–			
9.0 a.m.	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
11.0 a.m.		–				–		–		+						
1.0 p.m.		–				–		–		–		–		–		
2.50 p.m.		–				–		–		–		–		–		
4.0 p.m.		–				–		–		–		–		–		
4.45 p.m.	–	–	–		+	–	+	–								
5.30 p.m.		–		+		+										

Remarks.—The following samples were taken and sent to R.A.M. College:—
12/9/16: (6.30 p.m.), two samples, both reported sterile; (11.0 p.m.), two samples, both reported sterile.
13/9/16: (3.0 a.m.), one sample, reported sterile; (12.0 noon), one sample, reported sterile; (3.30 p.m.), two samples, one reported sterile one non-sterile.
14/9/16: (12.0 midnight); one sample, reported sterile.
15/9/16: (7.15 a.m.), one sample, reported sterile; (11.30 a.m.), one sample, reported sterile; (12.30 a.m.) one sample, reported sterile.

Conversion Table. Showing Lb. of Chlorine Per Hour.

Parts per Million.	Gallons of Water per Hour.										
	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400
1	0·004	0·005	0·006	0·007	0·008	0·009	0·01	0·011	0·012	0·013	0·014
2	0·008	0·01	0·012	0·014	0·016	0·018	0·02	0·022	0·024	0·026	0·028
3	0·012	0·015	0·018	0·021	0·024	0·027	0·03	0·033	0·036	0·039	0·042
4	0·016	0·02	0·024	0·028	0·032	0·036	0·04	0·044	0·048	0·052	0·056
5	0·02	0·025	0·030	0·035	0·04	0·045	0·05	0·055	0·06	0·065	0·07
6	0·024	0·03	0·036	0·042	0·048	0·054	0·06	0·066	0·072	0·078	0·084
7	0·028	0·035	0·042	0·049	0·056	0·063	0·07	0·077	0·084	0·091	0·098
8	0·032	0·04	0·048	0·056	0·064	0·072	0·08	0·088	0·096	0·104	0·112
9	0·036	0·045	0·054	0·063	0·072	0·081	0·09	0·099	0·108	0·117	0·126
10	0·04	0·05	0·06	0·07	0·08	0·09	0·1	0·11	0·12	0·13	0·14

is added to the paste and the black cup filled with water to the mark on the inside. This is stirred vigorously and the glass stirrer left in the black cup. One of the pipettes is put into the solution, which is never clear, as it contains lime in suspension.

(2) The six white cups are filled with the water to be tested to within ¼ in. of the top.

(3) Drops of the standard bleaching powder solution from the pipettes are added to the water in the white cups so that they contain 1, 2, 3, 4, 5 and 6 drops respectively. Each cup is thoroughly stirred with a clean rod, and this rod is left in one of the cups. The cups are allowed to stand for half an hour.

(4) After half an hour, three drops of the zinc iodide and starch solution are added from the dropping bottle, and each cup is stirred with the rod that was left in one of the cups.

(5) Some of the six white cups show no colour, while some will show a blue colour. The first cup which shows a blue colour, that is, the one containing the smallest number of drops, is noted. If cups 1, 2 and 3 show no colour and 4, 5 and 6 show a blue colour, then cup No. 4 is the one to be noted. The water will therefore require four parts of chlorine per million to sterilise it. If none of the cups show a blue colour, then the cups are washed out and the test performed again with 6, 7, 8, 9, 10, 11 and 12 drops of the bleaching powder solution in the cups.

(6) Each drop of the bleaching powder solution in a white cup of water corresponds to one part per million of chlorine.

(7) It is to be noted that only if the bleaching powder is fresh and good will this test accurately agree with the amounts of chlorine gas required for sterilisation. It serves, however, as a guide for the amount of chlorine to be added to the water by means of the Wallace and Tiernan chlorinator.

LAUNCHING OF SHIPS IN RESTRICTED WATERS.*

By Lieutenant-Commander H. E. Saunders, Construction Corps, U.S.N., Member.

At the last meeting of this society there was presented by the writer a paper dealing with methods employed to check the speed of vessels during launching, with particular reference to a type of friction launching brake developed and used at the Mare Island Navy Yard. A brief description of the launching and checking arrangements for the battleship California were given, together with a description of certain model experiments conducted in connection with this work. At the time this paper was submitted, however, the launch of the California had not yet taken place, and it was proposed to submit a second paper, in the present form, embodying a descripton of the launch and an analysis of the data obtained at that time.

Before proceeding to a detailed account of the launch, which took place on November 20, 1919, it may be well to note the principal characteristics of this vessel, as bearing upon the data set forth in the following paragraphs :—

Length overall	624 ft.
Breadth overall	97 ft. 5⅓ in.
Mean draught at launching...	14 ft. 9¼ in.
Launching weight complete, with cradle	14,610·5 tons.
Pressure on ways, per square foot	2·4 tons.
Mean declivity of ways ...	1¼ in. per foot.
Maximum velocity attained...	24·7 ft. per sec.
Velocity when brakes were applied	21·5 ft. per sec.

In order to obtain data for a complete analysis of the launching, every effort was made to provide sufficient recording apparatus for all phases of the operation. In addition to the standard drum chronograph previously employed at this yard, a second "direct-reading" chronograph was fitted and both machines connected to the ship by wires which were laid out over the ground ways. The arrangement of the chronograph was such that the special "clock," the chronograph dials, the two pressure gauges of the No. 5 brakes and the tachometer (indicating feet per second velocity) were all included in the field of view of the motion-picture camera. Fig. 1 is a view of the entire brake control station at the head of the ground ways, port side. Figs. 2, 3, 4, 5, and 6, which have been included in this paper, show, in considerable detail, the arrangement of hand pumps, brakes, chains and friction cables as actually installed.

No attempt will be made to include in this paper any details of the launch other than those having to do with the braking operations. The complete launching report, Mare Island plan No. 24,389, has been issued, and is now available for the information of those who may desire it. The following paragraphs are copied verbatim from this report :—

Operation of Hydraulic Launching Brakes.

"Before proceeding to a description of the behaviour of these brakes, it will be of interest to note briefly the organisation of the special brake detail and the instructions issued for the guidance of the members of this detail. It has already been stated that there were three full rehearsals of these operations prior to the launch, and that all the men were given an opportunity to watch the performance of the launching model, when specially rigged with cables and chains.

"The two groups of men operating the hand pumps were directly in charge of a supervisor on each side, who was to superintend the operation and the emergency release of the brakes on that side. It was conceivable that, in the event of a wire cable stranding or kinking, or part of the brake gear carrying away, it might be necessary to release the pressure in one or more sets of cylinders to avoid serious damage.

"The brakes were to be set as soon as their respective cables began to pull through (for the brakes Nos. 3, 4 and 5, port and starboard, this would occur at about 568 ft. level). As an additional signal, two large klaxons were to be sounded by the brake control officer at the head of the slip, when the ship had run the proper distance and the chain cables had straightened out. From the rate of pressure curve, previously determined at the launching of the Xane, it appeared that about 11 seconds would be required to apply the normal pressure of 850 lb. per square inch, and that in this time at least 200 ft. of wire would be drawn through the brakes. The initial pressure was set at 50 lb. in order to insure that there was water in each system and that the hydraulic rams would respond at the first stroke of the pump. The water service was turned on each set of brakes at the moment that the vessel was released.

"In case the speed of the vessel had not been sufficiently checked at 1,000 ft. travel (under normal conditions the vessel should have stopped dead in the water at about 900 ft. travel), emergency pressure, 1,150 lb. per square inch, was to be applied, the signal for this pressure to have been five or six short blasts of the klaxons. When the vessel had stopped dead in the water, the brakes were to be quickly released upon signal of the klaxons, to prevent the strain on the cables from drawing the vessel back toward the slip. Competent observers were stationed near each set of brakes, to note any unusual behaviour of the apparatus and to watch the performance of the brake crews. Arrangements were made to take motion-picture observations of two extra gauges on the port and starboard No. 5 brakes. The actual pressure, distance and time readings are shown on Fig. 9, page 723.

"The chain cables attaching the friction wires to the ship were flaked down on the floor of the slip so that each chain was clear of the others and separated from its own parts. The tumbling shores of course, had to remain until the vessel was released, and, although they were directly in the path of the chains, there was no interference and very few of the timbers were thrown about.

"From the moment that the vessel was released until she reached 648 ft. travel, everything functioned exactly as was planned. At about 560 ft. travel the chain cables began to straighten out, and at about 570 ft. travel the klaxon signal was given to apply normal pressure on Nos. 3, 4, and 5. Within less than one-half second the operators began pumping on these brakes, and the first application of pressure was sufficient to straighten out the chain cables. The brakes smoked considerably from the start, due to the fact that there was a protective coating on the wire cables of some fish oil preparation, which burned off on the outside of the

Fig. 1. Brake-Control Station.

Fig. 2. Number 3 Brake, Starboard Side.

* Paper read before the Society of Naval Architects and Marine Engineers at their New York meeting, November 11 and 12, 1920.

THE LAUNCHING OF SHIPS IN RESTRICTED WATERS.

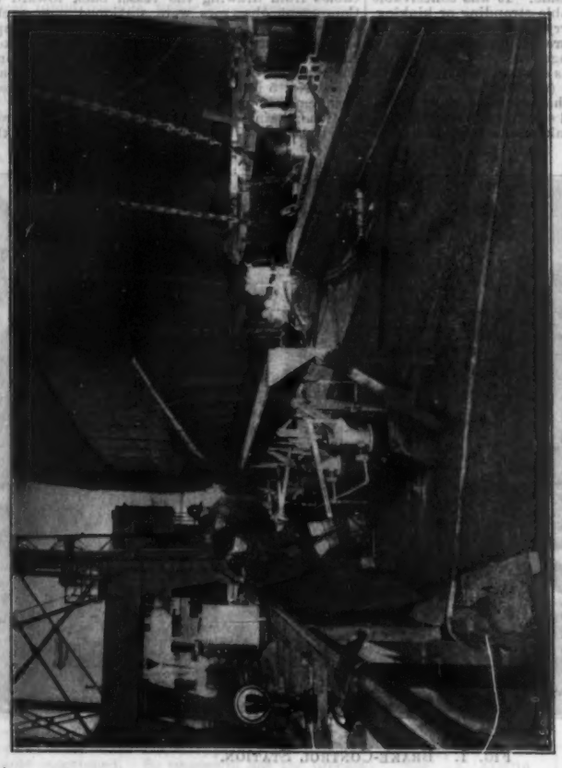


FIG. 4. BRAKE CREWS, STARBOARD SIDE.

FIG. 6. BRAKES, AND CHAINS, PORT SIDE.

FIG. 3. HAND PUMP AND GAUGES, PORT SIDE.

FIG. 5. GENERAL VIEW, PORT SIDE.

THE LAUNCHING OF SHIPS IN RESTRICTED WATERS.

Fig. 7. Number 1 Starboard Brake after Launch.

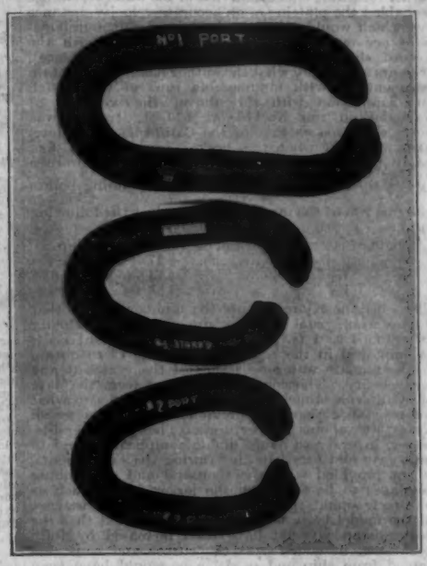
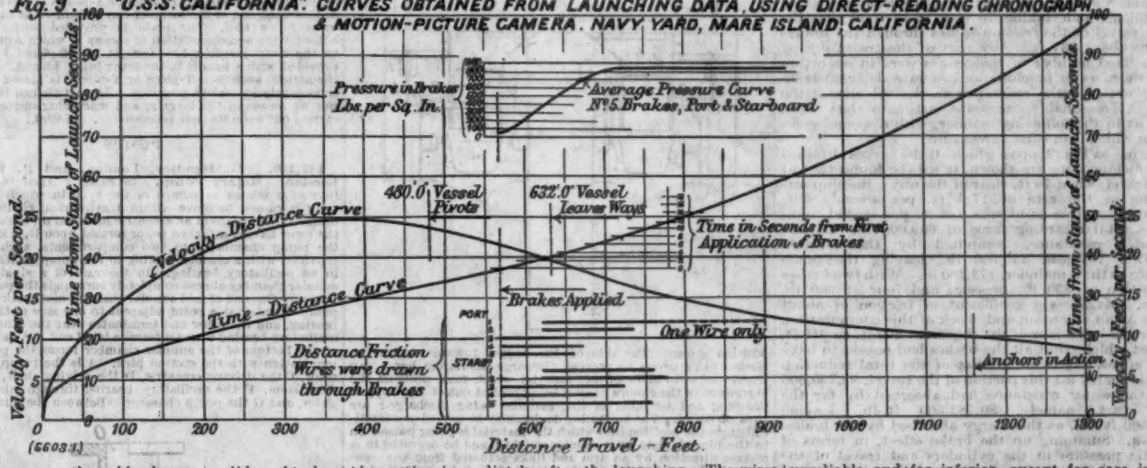


Fig. 8. Broken Links in Chains of Launching Brakes.

Fig. 9. "U.S.S. CALIFORNIA." CURVES OBTAINED FROM LAUNCHING DATA, USING DIRECT-READING CHRONOGRAPH & MOTION-PICTURE CAMERA. NAVY YARD, MARE ISLAND, CALIFORNIA.



strands as soon as the cables began to slide. At about 620 ft. travel the cables straightened out on No. 1 and No. 2 brakes, and normal pressure was applied by the operators.

"At 648 ft. travel, after the wires on No. 3 port brake had gone about 80 ft. through the blocks and a pressure of 500 lb. to 600 lb. per square inch had been applied to the rams, the chain cable on that brake carried away several feet from the pad on the ship's side. The vessel by this time had left the ways and was travelling at a velocity of about 19½ ft. per second. At 660 ft. travel, the chain cable on No. 5 port brake carried away about 420 ft. from the ship's side. The wire cable and the cable reels, travelling at high speed when the wires suddenly stopped in the brake, possessed enough momentum to throw the wires up in kinks behind the brake and to unwind several turns from the reels. Although the friction brakes on the cable reels were not supposed to care for such a sudden stoppage, they should properly have been set to exert considerably more resistance (see Fig. 7).

"One by one, as the pressure on the brakes was increased, their respective cables parted, about half of the chains remaining intact when normal pressure was obtained. At 776 ft. travel, all chains except No. 1 port had parted; at 780 ft., one of the links connecting the outside wire on No. 1 carried away and the inside wire continued to pull through the brake. Although no further signal was given at this time from the control station, the supervisor in charge on the port side motioned to the operator at No. 1 to hold the pressure on his brake. Mistaking this for a signal to apply emergency pressure, he immediately began pumping to about 1,100 lb. per square inch. At 902 ft. travel, as soon as this pressure had been applied, this chain cable also parted and the vessel was then running freely with the exception of the pieces dragging along from the pad-eyes. The starboard and port anchors were then dropped and the vessel brought to rest as described elsewhere in this report.

"Port No. 4 brake was dismantled and opened for inspection immediately after the launching. The wires had travelled about 100 ft. through the blocks, but there was no rifling and comparatively little scoring of the grooves. The leading end of the grooves showed practically no wear; the trailing end showed discoloration on the tops and bottoms of the grooves about ½ in. wide and 20 in. to 24 in. long. The concentration of pressure and the resultant generation of heat were almost sufficient to make the metal soft enough to flow. The same condition on the other brakes indicate that the water-cooling features of the brake must be improved somewhat and that the cooling must be most efficient where the greatest amount of heat is generated. The operation of all other parts of the brakes left nothing to be desired. There was no serious twisting of any of the cables; for instance, one wire of No. 1 port brake slid for about 230 ft. in its groove with no such effects whatever. Flats were worn on the outside strands and there was some discoloration of the metal, but the cables, after launching, were in perfect condition for use on the next battleship.

"Six of the broken links from the 10 chain cables were recovered, and every one showed either faulty weld or very inferior structure. On one link the weld was perhaps less than 10 per cent. effective, and on another there were crystals of metal ½ in. square. It is not likely that any one of these six cables pulled even its normal load of 30 tons, to say nothing of withstanding its proper breaking load of 83 tons.

"The fact that two of the cables broke before 600 lb. pressure had been applied to the brakes proves that neither excess load nor sudden application of load was responsible for the failure of the chains in this instance. The motion-picture records show clearly that the cables remained fairly taut and that there was almost no surging for the time that they remained intact. There was no apparatus at Mare Island with which to make physical test of these chains, and it is quite probable that even such tests, carried only to the proof strength of the chain, might not have disclosed serious defects. Chain cables for this purpose are considered treacherous and unreliable and far inferior, except for ease in flaking down, to wire ropes with suitable end fastenings. They have not been used in the past at this yard, and they will not again be used in the future.

"Although in this case the absolute failure of these chains to stand up to their work introduced some unforeseen complications, it is considered that the results, taken all in all, most fully justified the modifications which had been made in the original design of these friction brakes. It is interesting to note from the curves that, had the cables held and exerted their proper pull, the vessel would have been stopped in almost exactly the same distance as had previously been calculated.

An examination of Fig. 8 will indicate that some of the chain cables in question carried away before the defective links had suffered any deformation whatever. As an extreme example, it may be seen that the weld on the end link of No. 1 port cable opened out as if it had been simply bent to shape and never welded at all.

Aside from the question of chain cables, the functioning of the hydraulic brakes was, on the whole, so satisfactory that they will be retained in practically their present form for use on the battleship Montana, now under construction at the Mare Island Navy Yard. Two additional brakes are to be fitted, making a total of 12. Although the probable launching weight of the new battleship is almost 50 per cent. greater than that of the California, or about 20,000 tons, the necessary retarding effect is to be obtained by increasing the braking period, making use of the greater part of the channel fairway instead of attempting to stop the vessel in about 350 ft. Wire-connecting cables, secured to pad-eyes and lashed with small rope stops to the ship's side, will replace the former chain cables laid down on the slip, and the friction cables will be laid out in pipes or boxes instead of being wound on reels.

As a matter of fact, the unforeseen developments of the California launching were, in reality, the most valuable incidents that would have taken place. With the very high wind that was blowing across the fairway at the time of the launch it was indeed fortunate that

the vessel stayed on the mud on the far side of the channel long enough for the fleet of tugs to make fast. Furthermore, the fact that the ship ran for about 250 ft. with no other retarding effect than that of the water resistance has enabled the plotting of an accurate velocity-distance curve which would otherwise have been well nigh hopeless of accomplishment. This curve, taken with the full-sized ship (cradle and all appendages in place), represents accurately what the author has tried to obtain experimentally with innumerable runs of the model.

In connection with the above, the velocity of the model on run No.119, at 570 ft. travel, was exactly the same as that of the California at the corresponding point when the brakes were applied, *i.e.*, 21·5 ft. per second. A solution of the two formulæ $\left(K_1 = \frac{V^2}{S}\right.$ and $\left. K_2 = \frac{M}{V^2 S}\right)$ for corresponding points in the free run of the model and ship, gives the following results :—

Origin of velocity distance curve, ft.	Model.	Ship.
	+27·2	−13·1
K_1	13,085	11,630
K_2	81·64	87·2

The constant K_1 represents the number of feet that the ship would run in free route before the velocity were reduced to 1 ft. per second. The constant K_2 is that employed in the equation $R_w = K_2 V^2$ to obtain the approximate water resistance of the vessel at any given velocity. The constants obtained from the data of the California launch show that the ship had somewhat more resistance than the previous model runs would indicate, by about 6½ per cent. The model cradle, however, in order to avoid undue complication and to permit easy and safe handling during the experiments, was not provided with the thousand and one minute appendages to be found on the larger vessel, such as wire rope frapping, spreaders, securing lines and wedges. Had the model been so fitted, it is considered that the water resistance would have been increased by fully 5 per cent., in which case the curves and constants obtained from ship and model runs would have been in remarkably close agreement.

A direct comparison of the brake-resistance curves of the model and the ship, and the plotting of the probable brake-resistance curve of the California is a somewhat difficult undertaking, in view of the fact that the average travel of the friction cables through the brakes was only about 137 ft. Any part of the travel during which a fixed number of the brakes were in operation was so short as to preclude an accurate determination of the effect of brake resistance on the velocity of the vessel. A reasonably accurate estimate has been arrived at in the following manner, with a second computation which is in close agreement.

Referring to Fig. 9, upon which all the curves obtained from launching data are shown, it will be found that at 710 ft. travel, when 78 ft. clear of the ways, the ship was travelling at the rate of 17·1 ft. per second. The deceleration at this point was 0·6 ft. per second, indicating a total retarding force of 609,000 lb. Of this the water resistance, computed by the formula $R_w = 87{\cdot}2\ V^2$, was 435,800 lb., leaving the brake resistance as the remainder, 173,200 lb. With two brakes in operation at 830 lb. pressure and four at 600 lb. pressure, this gives a coefficient of friction of about 0·129. As an extension and check of this computation, consider the behaviour of the ship from 600 ft. to 910 ft. travel, at which point all the brakes had ceased to have further effect. It is found that of the total reduction in kinetic energy for this portion of the travel, 98,730,000 ft.-lb., the water resistance had absorbed by far the greater part, namely, 80,782,500 ft.-lb., leaving 17,947,500 ft.-lb., as the energy absorbed by the brakes in action. Summing up the brake effect, in terms of hydraulic pressure in the cylinders and travel of the respective friction cables, it is found that the average coefficient of fricton is about 0·123. This figure, which is but slightly different from that above, gives an average coefficient of friction of 0·126, as compared with the coefficient of 0·24 as found by the preliminary experiments of a year and a half ago.

It must be remembered, however, that these tests were carried out with the limited means then at hand, which permitted only a comparatively short pull on one friction wire at a rate not exceeding about ½ ft. per second. It must be remembered also that the tests were conducted with only two cables, which presented clean, bright surfaces to the brake blocks on most of the runs. The friction cables in place at the time of the launch, however, were covered with a partly-oxidised coating of heavy oil, just as they had been delivered by the contractor, and the presence of this oil coating may possibly have reduced the friction by an appreciable extent. It appears quite likely, therefore, that at the speeds and temperatures at which these brakes run during a launching operation there is a considerable reduction in the assumed coefficient of friction, although the data given above are unfortunately neither sufficiently accurate nor extensive to fix this value within very close limits.

In connection with the launching of the battleship Montana the model is now being rebuilt and the apparatus slightly modified. The tank will be increased in width from 40 in. to about 72 in., and the new model will be provided with all the minute appendages in addition to the launching cradle. The subject of stern masks having been brought into prominence during the discussion on the previous paper, some experiments will be carried out on the Montana model with masks of different sizes and shapes. As an example of the effectiveness of any means of increasing the water resistance, it may be noted that for the California (hull and cradle alone) the value of this resistance at the moment that the ship left the ways was 667,000 lb., or just short of the total normal brake pull on the 10 brakes.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

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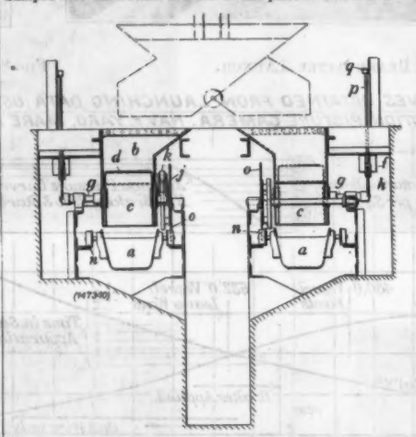
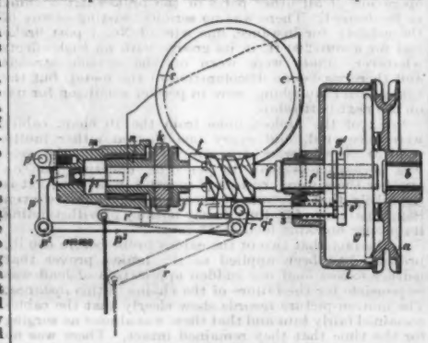
LIFTING AND HAULING APPLIANCES.

147,340. J. West, Southport, and West's Gas Improvement Company, Limited, Manchester. Conveyors. (4 *Figs.*) June 26, 1919.—The invention relates to conveyors of the gravity bucket type, and particularly to the means employed for passing coke from the lower ends of vertical retorts into the buckets. The material is fed into the conveyor buckets *a* from a hopper *b* having a measuring device at its lower end which is controlled to deliver the material when each bucket comes into position beneath the hopper. The said measuring device comprises a hinged plate, as *c*, forming one side of the lower part of the hopper and having a sector like part at one end which forms a closure piece to close the outlet from the hopper. When the hinged plate *c* and closure piece *d* are turned to withdraw the latter, and so open the exit from the hopper *b*, a quantity of the material from the hopper piles up upon the hinged plate *c*, which now rests in a more or less horizontal position. On again turning the plate *c* to bring the closure piece *d* across the hopper exit, the material beneath *d* and supported by the plate *c* is dumped into the bucket beneath as the plate is returned to the



position shown. The side of the hopper towards which the closure piece moves to prevent discharge therefrom has a gap therein so as to allow of any material which may obstruct the movement of the closure piece *d* being pushed out of the hopper. Crushing and breaking of the material being discharged are thus obviated. The measuring device may be moved automatically into the position into which the material is being passed on to the hinged plate by a counter weight *f*, and be operated in a reverse direction by an arm and links actuated from the conveyor. Thus the plate *c*, with closure piece *d*, has attached to the hinge pin *g* an arm *h*, with counterweight *f*, and an arm *j* with a roller *k* at its outer end, which is intermittently engaged by the respective members of the star cam to which radial movements are imparted by the engagement of the conveyor rollers *n* with the grooved wheel *o*, to which the said star cam is adjustably secured. By means of a rod, as *p*, connected at its lower end with the aforesaid lever *h*, and provided at its upper end with a grip or handle *q*, the measuring device may be put out of action when delivery of material to the conveyor buckets is not desired. (*Sealed*)

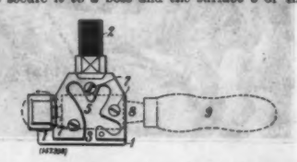
148,093. W. H. Vaughan, Manchester, and F. Wood, Manchester. Hoisting Appliances. (1 *Fig.*) December 13, 1919.—The invention relates to worm-geared hoisting appliances. The hand-operated chain wheel *a* is mounted loose upon a stud *b*



carried by the frame, and is controlled by a chain or rope from below in order to start hoisting. The winding drum *c* is formed or combined with a worm wheel from which the load is raised or lowered. The worm wheel meshes with a worm carried on a shaft *f* which, during hoisting, is actuated by rotating the hand-operated chain wheel *a* when the teeth on its side face are engaged with similar teeth on the controlling brake disc *g*, which is mounted on a feather key in the worm shaft *f*. The gravity lowering brake is contained within the flanged brake shell *i*. Further, the sustaining brake comprises a boss *j* fixed upon the worm shaft *f*, and a combined loose friction disc *k* and retaining ratchet, but instead of relieving the sustaining brake by partially rotating the screwed shaft, a sliding plunger *l* fitted in a cylinder *m* and connected to the end of the worm shaft *f*, which is fitted to slide longitudinally in its bearings, of which the bush *n* forms one, is employed. The plunger *l* is connected by an extension *f1* of the worm shaft *f*, and an anti-friction ball contained in a recess in the plunger *l*. The levers consist of a lever *p* fulcrummed at *p1* to the end of the cylinder *m*, and at its other end pivoted at *p2* to a connecting rod *p3* fulcrummed on the first floating fulcrum in the angle of the main operating lever *r*. The toe of the operating lever *r* carries the second floating fulcrum *q2*, which is pivotally connected to a sliding rod *s*, which at the other end is formed as a clutch die *s1* engaging a groove *g1* in the boss of the gravity lowering brake *g*. The other end of the rod *s* passes through a hole in a stationary bracket *t* which forms part of a stationary plate fixed to the frame. (*Sealed.*)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

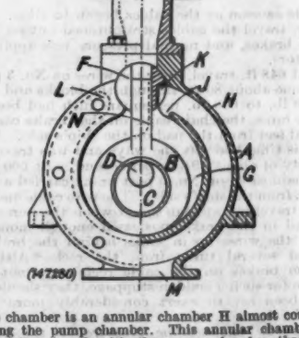
147,398. R. W. Thomas, Birmingham. Jigs for Use in Drilling. (5 *Figs.*) December 9, 1919.—The invention relates to jigs for drilling or machining connections such as T-shaped connections or Y-shaped connections such as are commonly used on motor vehicles for connecting the front and rear lamp tube. The jig is of the kind which comprises a body member which is provided with a recess adapted to hold the T-piece or Y-piece in three different positions, in each one of which a different end is brought and held opposite to the tool. The body member 1 is provided with a shank 2, which is screw-threaded to secure it to a boss and the surface 3 of the body



member 1 instead of being recessed is left plain. Secured to the surface 3 of the body member 1 is a separate plate provided with a slot 5, extending through its thickness, the slot being shaped to accommodate T-pieces or Y-pieces in several positions, so that each end of the member can be held so as to be operated upon by a tool. The plate is provided with countersunk holes for the accommodation of screws 7, which secure the plate to the body member 1. The jig is completed by a lever 8, provided with a handle 9, the lever being hinged. In operation the article, such as a T-piece or Y-piece, is placed in the slot 5 successively in various positions. The article can be held in the slot by means of the lever 8, and machining operations can be carried out upon its ends successively. (*Sealed.*)

PUMPS

147,280. G. Handley, London, and P. W. Bullock, London. Rotary Pump. (8 *Figs.*) April 16, 1919.—The invention relates to pumps of the type in which a cylindrical rotor is caused to move within a cylindrical chamber of larger diameter, by means of an eccentric mounted on the driving shaft, the rotor having attached to, or formed upon it, a stem dividing the pump chamber into two compartments, such stem being provided with a channel leading to the pump outlet, and sliding in an oscillatory bearing. In the case of a single pump, the annular chamber almost completely surrounds the pump chamber proper. One end of said annular chamber communicates with the pump chamber at a point adjacent to one side of the oscillatory bearing, and the other end terminates near the other side of the oscillatory bearing where it forms a blind end. A flanged opening at the bottom of the annular chamber forms the point of communication with the suction pipe. A is the pump body, B the rotor, C the driving eccentric, D the driving shaft, working the rotor stem, F the oscillatory bearing through which the stem slides, and G the pump chamber. Between the pump body and



the pump chamber is an annular chamber H almost completely surrounding the pump chamber. This annular chamber communicates at one end with the pump chamber through an opening J adjacent to the oscillatory member which is channelled at K as shown. The other end of the annular chamber terminates at L in a dead end near the other side of the oscillatory bearing. A flanged opening at M forms the communication with the suction pipe. The outlet from the pump chamber is through a channel N in the stem of the rotor leading to a flanged opening O. During the first portion of the cycle of operations, the suction is increasing and the pump draws upon the body of liquid nearest to the inlet, namely, that in the annular chamber. The residual air left in the upper part of the blind end of the annular chamber serves as a spring and by expanding allows the liquid on that side to descend, partly taking the place of that first drawn upon and preventing undue acceleration of the stream in the suction pipe. During the second part of the cycle, suction diminishes to zero and the stream of liquid from the suction pipe instead of being checked, flows into the blind end of the annular chamber, the residual air at this end contracting after its previous expansion, and allowing the liquid to take its place. Thus the liquid in the annular chamber has a regular oscillatory motion while the flow in the suction pipe is steady. (*Sealed.*)